Heating Piping & Air Conditioning

MARCH 1960

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. . . for Consulting Engineers • Mechanical (Heating, Piping, and Air Conditioning) Contractors • Engineers with Plants and Big Buildings

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Wall fin tubing, radiant floor panels, warm air . . . all three heating methods are integrated effectively into the unique architecture of the new headquarters office building of the American Society for Metals

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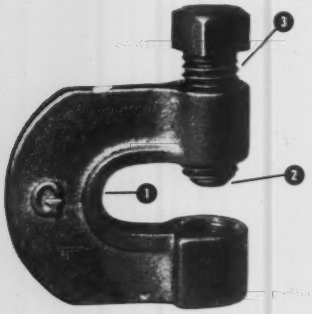
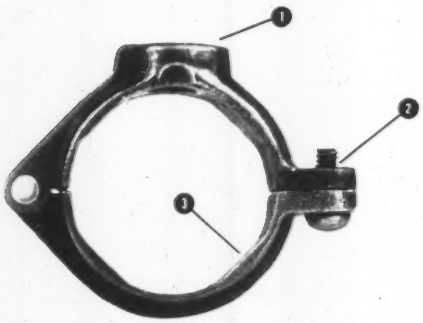
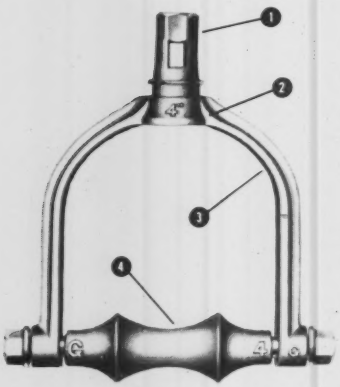
Look at all the extras you get in Grinnell Pipe Hangers . . . yet you pay no more!



GRINNELL C-CLAMP, FIG. 88 — 1 Ribbed, malleable iron casting, for extra strength **2** Hardened steel, cup-point set screw for good "grip" on beam **3** Full thread engagement – casting is drilled and tapped for rod and set screw



GRINNELL EXTENSION SPLIT RING, FIG. 138 — 1 Nipple engaging thick section of malleable iron gives rigidity for support from above, below or from wall **2** Tapped to take screw. No nut to lose **3** Special ring contour holds pipe or tubing firmly



GRINNELL ADJUSTABLE SWIVEL PIPE ROLL, FIG. 174 — 1 Swivel shank permits adjustment without elaborate support **2** Locking device prevents accidental adjustment change; no lock nut required **3** Ribbed design in malleable iron for better strength, lightness, appearance **4** Easy installation; maximum adjustment

GRINNELL CB CONCRETE INSERT, FIG. 282 — 1 One body size accommodates several sizes of rods **2** Slot takes reinforcing rods to assure maximum load rating **3** One-piece body prevents concrete seepage **4** Teeth on insert and nut hold rod firmly in place **5** Homogeneous composition of malleable iron throughout

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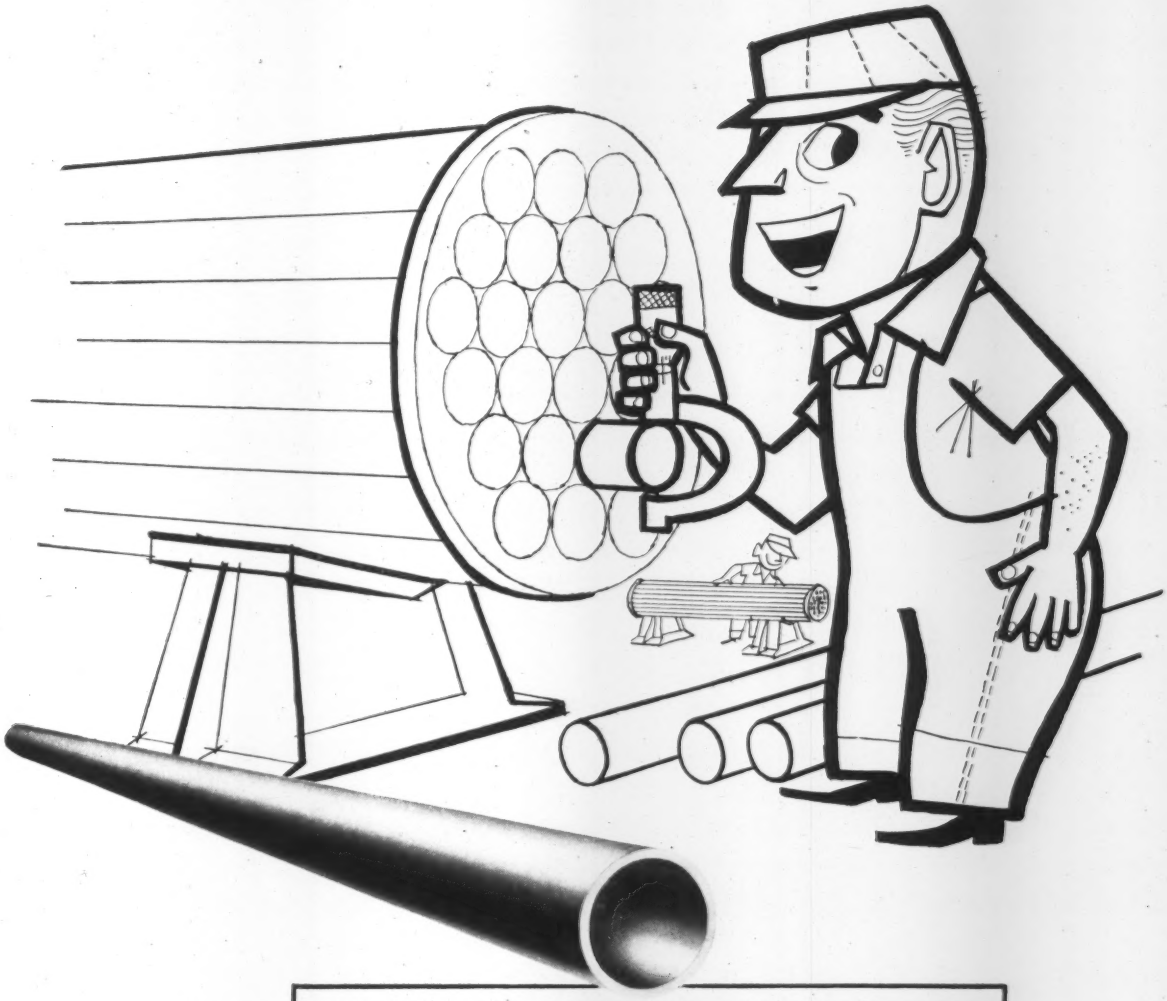

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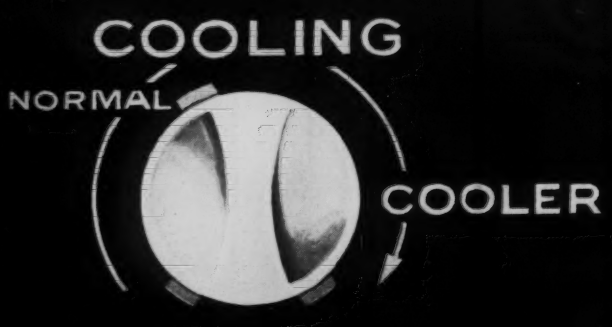

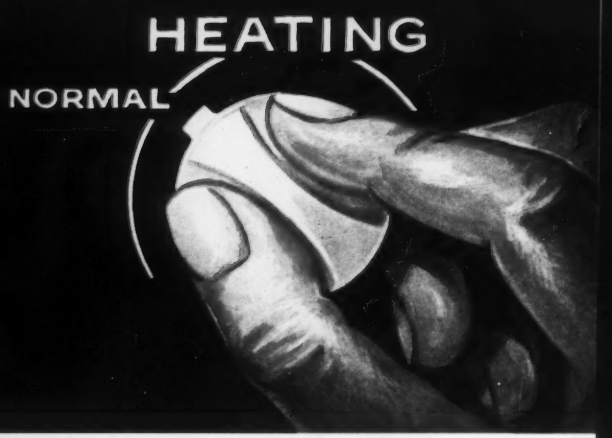

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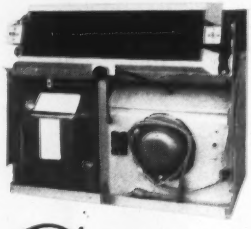

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VOL. 32, NO. 3 MARCH 1960

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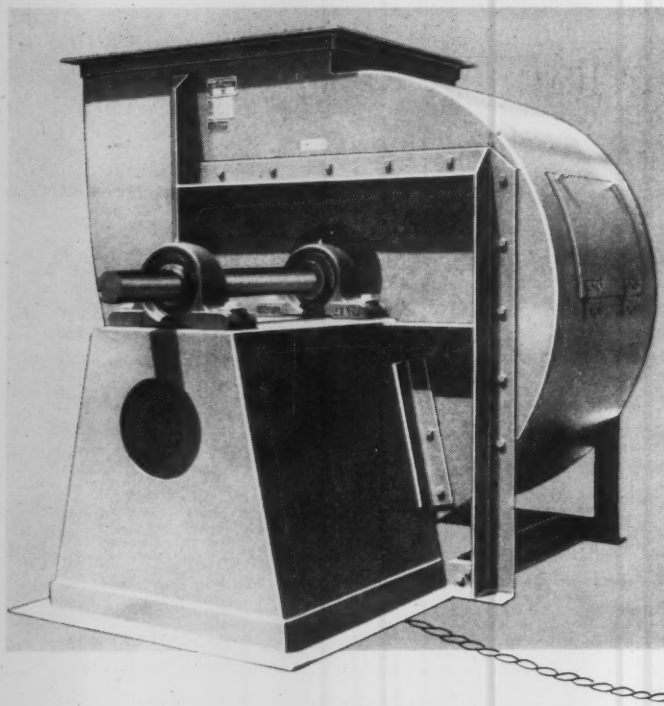

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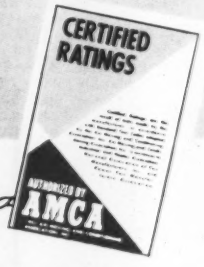

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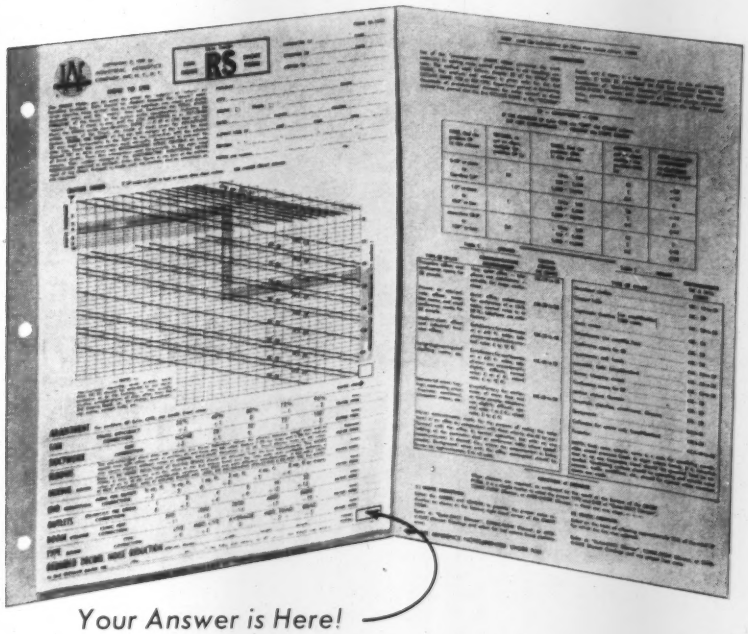

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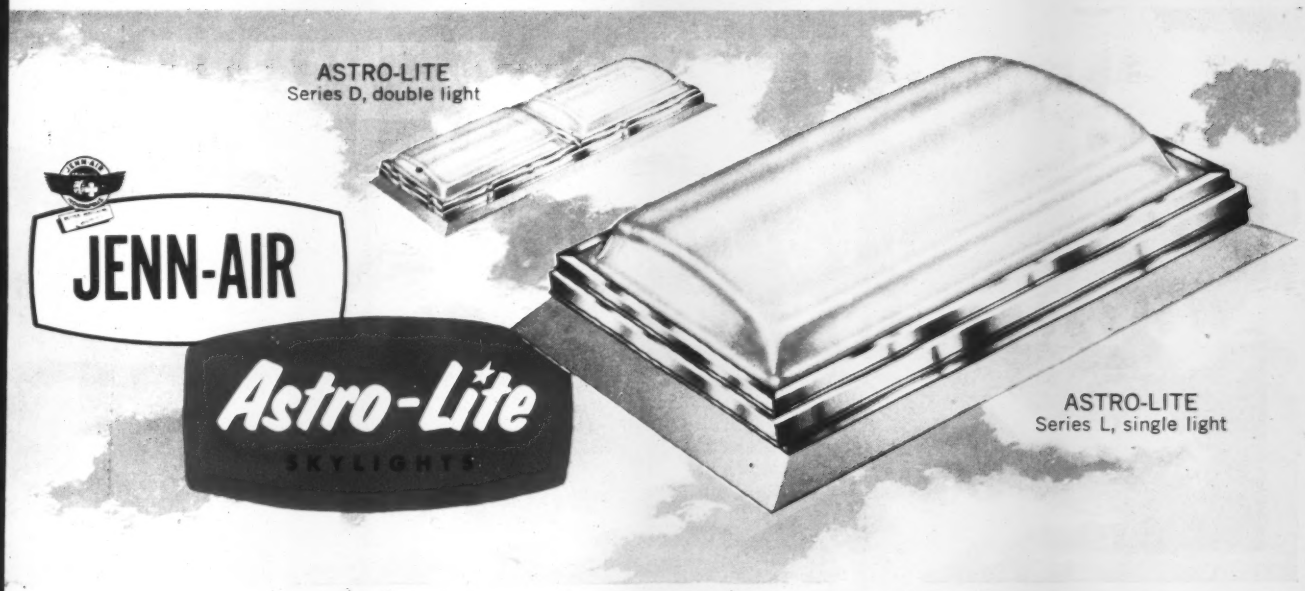

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LETTER FROM THE EDITOR

March 1960

Dear Reader:

The new unusual looking structure shown on the cover this month really offered many challenges to the consulting engineers and the mechanical contractors in designing and installing the heating systems. It is the new headquarters for the American Society for Metals located on a 100 acre wooded site 23 miles east of Cleveland. The 250 ft diameter, 200,000 lb metal lattice stands on five large pylons which extend 77 ft down to bed rock. About 20 ft below the ground level the pylons are joined by a tension ring which keeps the footings from spreading. The dome will never be enclosed or covered, according to the Society, as it is intended to stand as a monumental masterpiece in modern metals technology.

In a semicircle at the base of the dome is a three story office building. The curving office units, 240 ft long and 53 ft wide include glass curtain walls to give a panorama of the woods, hills, and sky. Of course, to achieve this effect through the large glass areas, the heating problems were magnified greatly.

In addition to the large glass areas, the floor design and construction made it mandatory that floor panel heating be used. Of course future air conditioning was in the planning also. It was decided by the consulting engineers, Mayer & Valentine, to use three types of heating to satisfy these different requirements. The article is on page 105.

A basic explanation of how temperature and velocity of potable water affect corrosion of copper and copper alloys is given on page 109. The authors, Dr. Obrecht and Dr. Quill from Michigan State University, explain that corrosion of non-ferrous metals in aqueous solutions may be due to any of six types. All of these really result in a "wearing away" of the metal, by either a chemical or physical action, or a combination of these two. This article is the second one in this series in which extensive results of research on this subject is being reported.

Air cooled condensers continue to draw much attention, and this month Warren Viessman points out on page 117 that air cooled condensers need not be limited to small installations. He presents five important economic considerations that affect the application and practical size limitations. Some of these are air temperature, life of the equipment, and the length of the refrigerant circuit.

Flexible metal pipe connectors seem to be one answer to an inherent problem faced by consulting engineers, mechanical contractors, and large building engineers in designing, installing, operating, and maintaining baseboard and finned pipe steam and hot water heating systems for tall buildings. Lewis Smith, author of many articles in Heating, Piping & Air Conditioning, explains in his article on page 118 how cost savings are achieved by using these connectors. The big problem, of course, is to make connections for the risers in the tight space available and still allow for expansion. Mr. Smith points out that savings will often result in a lower overall installation cost because of the reduced time required to install the system, even though the flexible connectors may cost more.

Heating and air conditioning a 64 year old building always presents many interesting and unusual problems. The limited space available for ductwork along with several other factors led the consulting engineers to decide that two related but independent types of systems should be used to serve the varying heating loads during all seasons. The article is on page 122 and the author is Anthony F. Manna.

LETTER FROM THE EDITOR

Calculating pipe stresses for permissible flexibility of the piping for process and power applications should be done early in the design before the equipment is selected. In order to do this, standard allowable stresses that can be tolerated on pumps, boilers, heat exchangers, and tanks are needed, according to Theodore E. Bridge, in his article on page 125. He proposes a standard for these tolerances in his article and also shows how to write and use a computer program for calculating pipe stresses. Mr. Bridge points out that care should be taken in preparing the program for the computer and after it has been written, it should be used intelligently.

Sam Lewis says "The day of open stairways in primary schools without automatic sprinklers is about past" in his regular feature which is on page 129 this month. He reports some interesting facts obtained from over 40 test fires conducted in a condemned Los Angeles school building recently. Various effects as to smoke and temperature conditions were photographed and recorded. The results emphasize the importance of complete automatic sprinkler systems, mechanically linked with a water flow alarm and with the community fire department.

Hot water heating systems today are frequently controlled, in part, by resetting the supply water temperature in accordance with outdoor temperature changes. The HPAC Data Sheet on page 131 includes a nomograph which may be used to determine the performance of hot water heating systems to which outdoor reset control is applied.

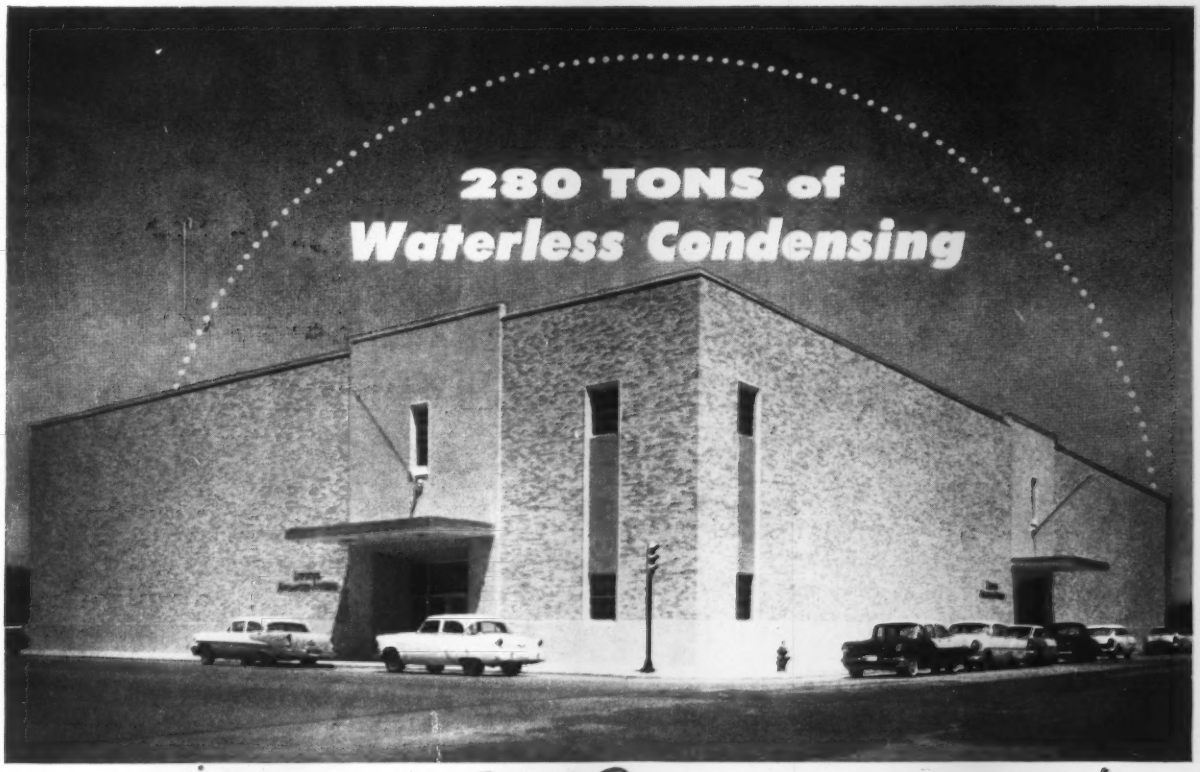
A basic comparison between the air conditioning design for today's ship and that for the modern hotel is presented by John W. Markert on page 134. The structural requirements of a ship and its great mobility present considerations which impose unique design problems. Some of these problems are compactness, windowless areas, watertight boundaries, and lack of uniformity between various decks. Great care is needed in designing the systems as far as odor control, noise, drafts, and close temperature control and Mr. Markert explains how these are achieved.

Direct fired heaters can provide excellent winter space heating and summer air circulation in industrial plants if they are properly applied. How to apply these direct fired heaters is explained by M. H. Stern in his article on page 138. He points out that effective air flow is an important factor in determining the number and location of units to be used. He also gives seven points that will aid in finding the best locations such as using floor mounted units whenever possible and locating heaters to achieve good air distribution without exceeding the air throw capacity of the heater. He also explains how to calculate the effective air throw from these heaters and how ducts and nozzles can be used to solve air distribution problems.

Evaporative cooling is often overlooked as a means of providing satisfactory indoor environments or a supply of cooled air for process cooling. The HPAC Engineering Data File on pages 141 to 158 contains a thorough explanation of the fundamentals of evaporative cooling and what should be considered in designing these systems to achieve maximum results. Comfort cooling applications with evaporative cooling have been used extensively for relief cooling in hot industries and also in churches and stores. Evaporative cooling wisely used and carefully designed may be a very effective way to provide the desired conditions. This Engineering Data File is another one worth reading and saving for future reference. I hope you are finding the perforated pages to be helpful when you remove these Engineering Data Files from each issue.

Bob Roose

Editor, HEATING, PIPING & AIR CONDITIONING



The Avalanche Journal Building, Lubbock, Texas. W. A. McMillan, Architects; Hedrick and Stanley, Engineers; Anthony Co., Mechanical Contractors.

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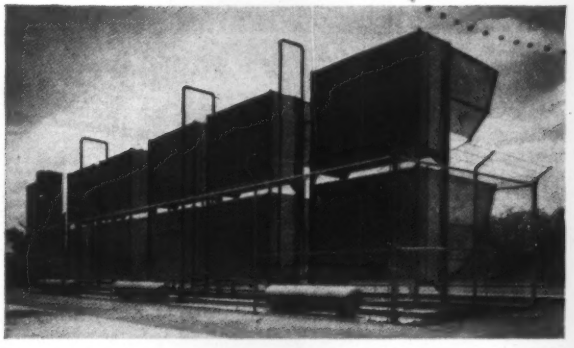

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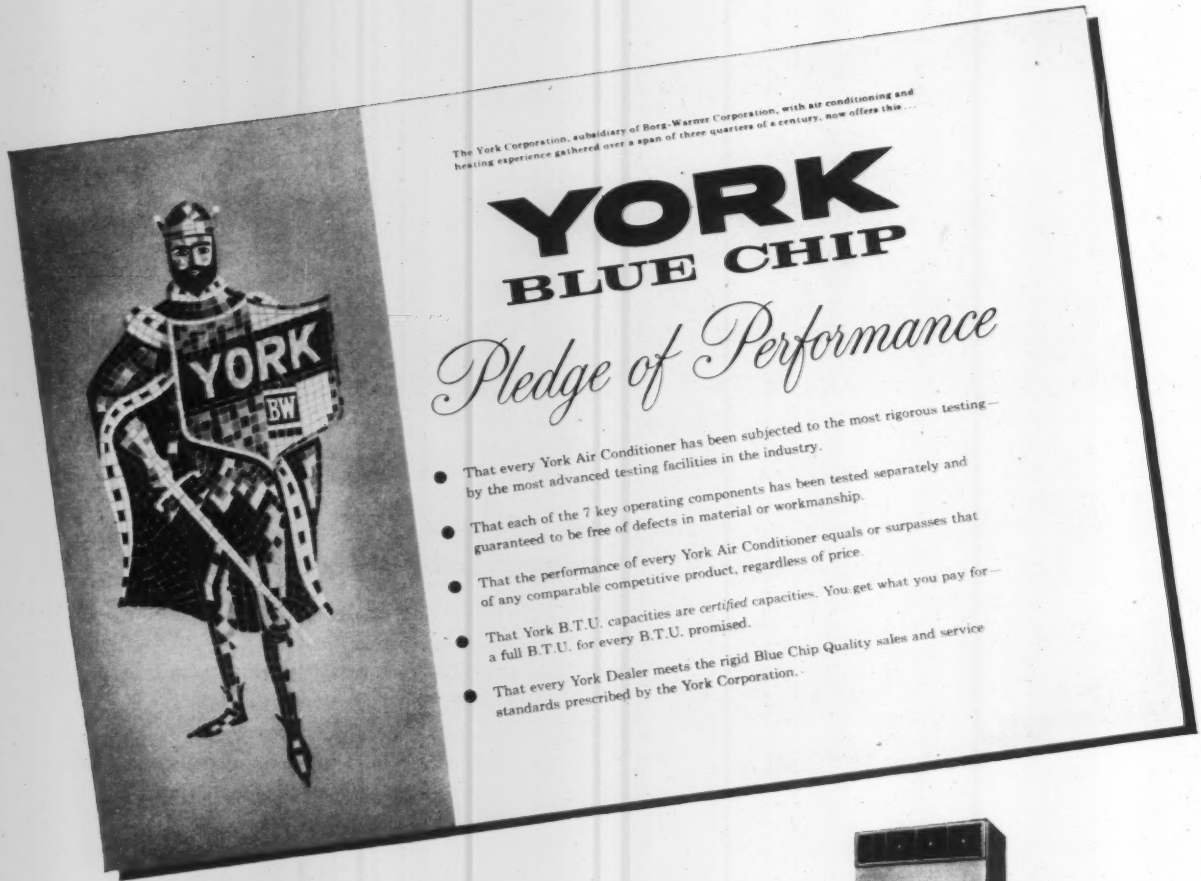
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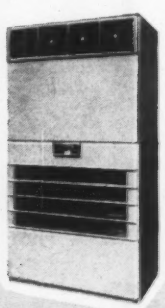
That each of the 7 key operating components has been tested separately and guaranteed to be free of defects in material or workmanship.
That the performance of every York Air Conditioner equals or surpasses that of any comparable competitive product, regardless of price.
That York B.T.U. capacities are certified capacities. You get what you pay for— a full B.T.U. for every B.T.U. promised.
That every York Dealer meets the rigid Blue Chip Quality sales and service standards prescribed by the York Corporation.

NEW BLUE CHIP
INCENTIVE BONUS FOR DEALERS!

All York Dealers are eligible for a full week's vacation at fabulous San Juan, Puerto Rico! Every recreational facility; lavish entertainment; air travel both ways...all expenses paid! Some may even qualify for a dream vacation to hallowed, old-world Rome!



York Commercial Air Conditioners
Compact, self-contained units. 3 to 33 ton capacity. Multi-compressor. Also low ambient Champion models.

Pledge of Performance

Dividend for 1960!

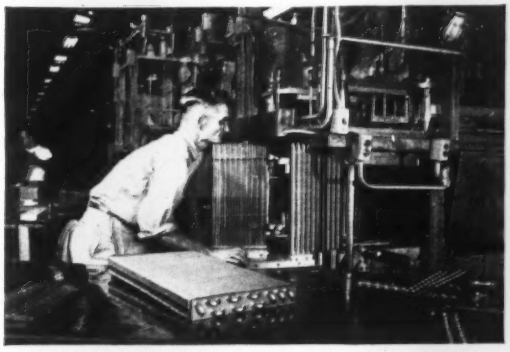
Your Guarantee of the Most Rewarding Advantages in Air Conditioning History!

Longest Trouble-Free Performance! Because each unit is inspected and certified by air conditioning experts using the most advanced testing facilities!

Most Value per Dollar! York's creative engineering, ultra-modern styling, and skilled craftsmanship make the big difference!

Greatest Profit Potential! High-speed production, rigid quality control, and quantity purchasing let you sell competitively...at a higher markup.

Finest Inventory Supply Program! York factory personnel and distributors work with you to establish a realistic inventory program!



Made Possible by New High-Speed Production Techniques

Includes assembly lines with power-driven conveyors that never stop; new multi-spindle milling machines; automatic refrigerant-chargers; automated punch presses, electrostatic painting devices and much more!

Plus New Advanced Quality-Control Facilities

York uses the most modern testing instruments available to check and recheck BTU capacities, sound levels, air flow CFM, wiring, voltages, everything! The object: to make York units that perform better, last longer, cost less!

York puts more into every unit, so you get more out of it

YORK YORK B-W DIVISION

BORG-WARNER RESEARCH & ENGINEERING MAKE IT BETTER

York Corporation, Subsidiary of Borg-Warner Corp.

Air Conditioning, Heating, Refrigeration and Ice-Making Equipment. Products for Home, Commercial and Industrial Installations

MAIL COUPON

General Sales Manager
Packaged Products Div. HP-3
York Corporation
West Grantley Road, York, Pennsylvania

Gentlemen:
I'm interested! Send me full details on York's Pledge of Performance and profit planning.

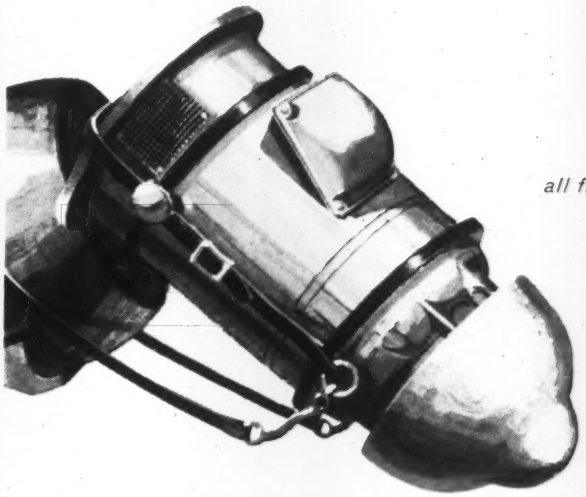
NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE____

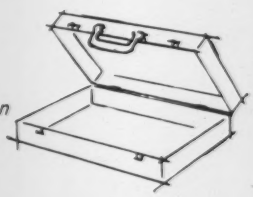
THE CASE OF THE
A. O. SMITH MOTOR MAN

A.O. Smith has the horses!



800 to 1 hp favorites for quiet operation, low maintenance and long-life service . . .

all from the case of the A. O. Smith Motor Man



The horses of A. O. Smith make up the dandiest remuda an integral motor user ever saw. A complete line of long-lived "easy keepers" — that includes . . .

SINGLE-PHASE DRIPPROOF INTEGRALS (1-5 hp). Tough rolled-steel frames have mountings harnessed to either old or new NEMA standards. Exclusive *sealed* starting switch keeps 'em running free and easy.

POLYPHASE DRIPPROOF INTEGRALS (1-800 hp). These front-runners are sound of wind, thanks to extra-value ventilation and insulation . . . sound of limb, thanks to extra care in electrical and mechanical design.

And A. O. Smith delivers the horses! Our motor man near you is on his mark with 24-hour action on all parts and service orders. He'll also show you a complete line of fractional-hp motors.

COPYRIGHT 1960, A. O. SMITH CORP.

Through research . . . a better way

A.O.Smith

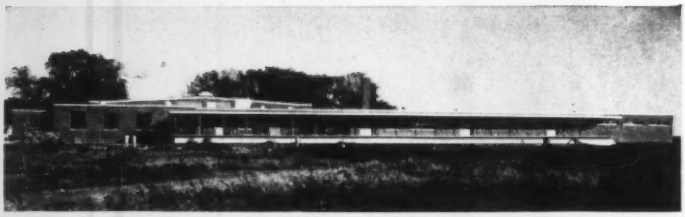
CORPORATION

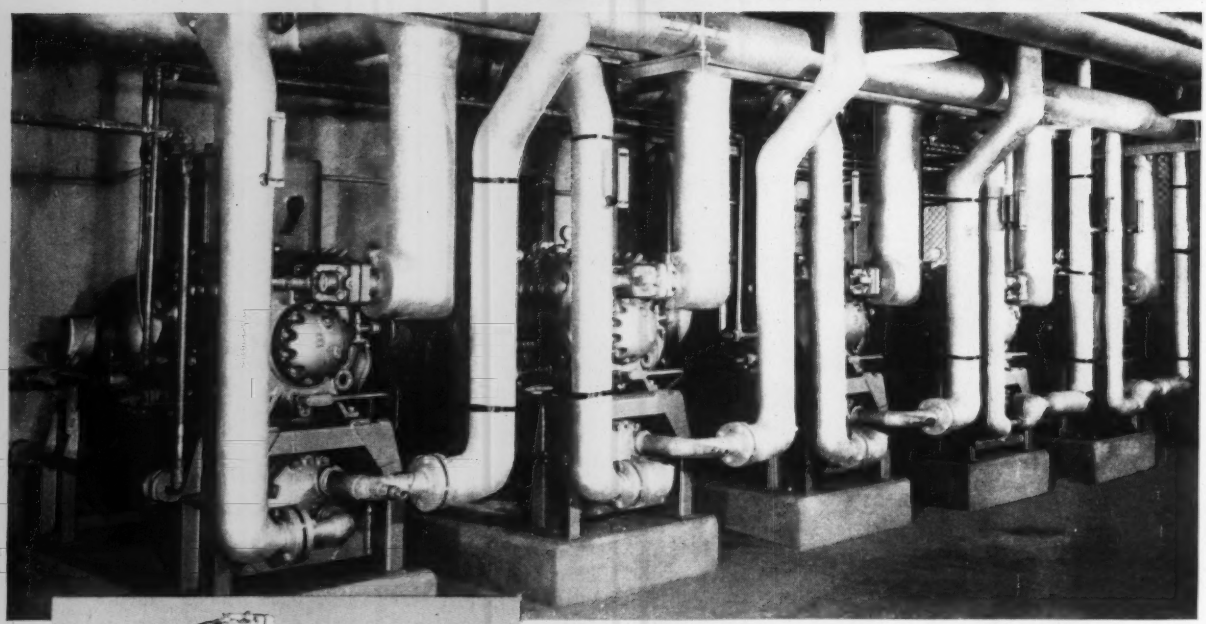
ELECTRIC MOTORS

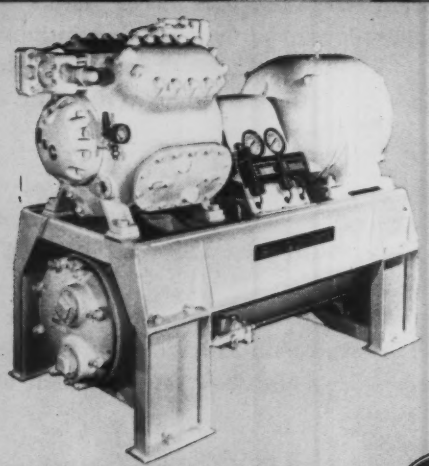
Tipp City, Ohio

A. O. SMITH INTERNATIONAL S. A.
Milwaukee 1, Wisconsin, U. S. A.

B&G® CONDENSING UNITS SELECTED FOR KANKAKEE, ILLINOIS, STATE HOSPITAL







B&G CONDENSING UNIT
An achievement in design, featuring interchangeable vital parts. 7½ through 150 tons. Performs with effortless smoothness, but with rugged brute strength available when required.

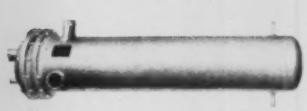
This modern institution was constructed in 1959 under the direct control of the Division of Architects and Engineers of the State of Illinois. The consulting engineers for the mechanical equipment were E. R. Gritschke & Associates, Chicago, Illinois. Burge Ice Machine Co., Chicago, Illinois, made the installation. The B&G low temperature equipment selected to meet the exacting food preservation requirements of this installation was three 25 HP and two 20 HP low temperature Condensing Units.

The B&G Compressor is a notable advance in refrigeration engineering. It is distinguished by *quieter operation —less vibration!* All Compressors have *one* bore diameter —a few interchangeable parts will service all units, reducing maintenance problems.

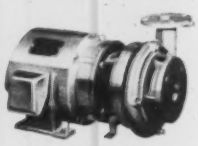
Remember, too, that *all* major parts of B&G "package" units are made and guaranteed by Bell & Gossett Company. This "plus" design feature means greater dependability—greater value per dollar.

BELL & GOSSETT
COMPANY
Dept. RGC-5, Morton Grove, Illinois
Canadian Licensee: S. A. Armstrong, Ltd.
1400 O'Connor Drive, Toronto 16, Ontario

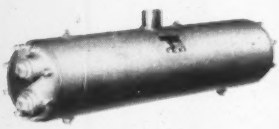
A COMPLETE LINE OF REFRIGERATION AND AIR CONDITIONING "PACKAGES" AND COMPONENTS



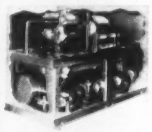
B&G Evaporators



B&G Centrifugal Pumps



B&G Condensers



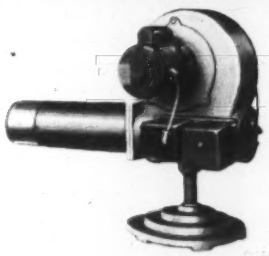
B&G Package Liquid Coolers

ENGINEERING NEWS

NATIONAL AIROIL BURNER CO., INC. • 1284 E. Sedgley Ave. • Philadelphia 34, Pa.

You may wish to check certain items in this advertisement and forward to those concerned in your company.

ROUTE TO:



Have You Investigated Nairoil Automatic Oil Burners?

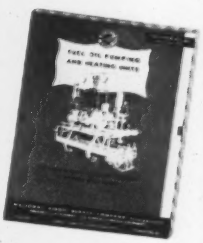
Here's a line of quality oil burners that is ideal for firing small steam or hot water boilers, air heaters, and other process furnaces in either horizontal or vertical upward position. Blast tube can be extended up to 12" for use with extra thick furnace walls. Powered with the latest type motor and available with electronic combustion safety controls, Nairoil Automatic Oil Burners operate on 110 Volts, 1 phase, 60 cycles. Other voltages and frequencies are available. Capacities from 0.75 to 20 gph. All Nairoil units meet U.S. Standards CS-75-56 and carry the Standard Underwriters Label. Complete details are available in Bulletin 113B. May we send you a copy?

Here's a Reliable Way to Prepare Heavy Fuel Oil for Combustion

If your heating problem involves the preparation of heavy fuel oil for combustion, you'll want to investigate the advantages of National Airoil Fuel Oil Pumping and Heating Units.

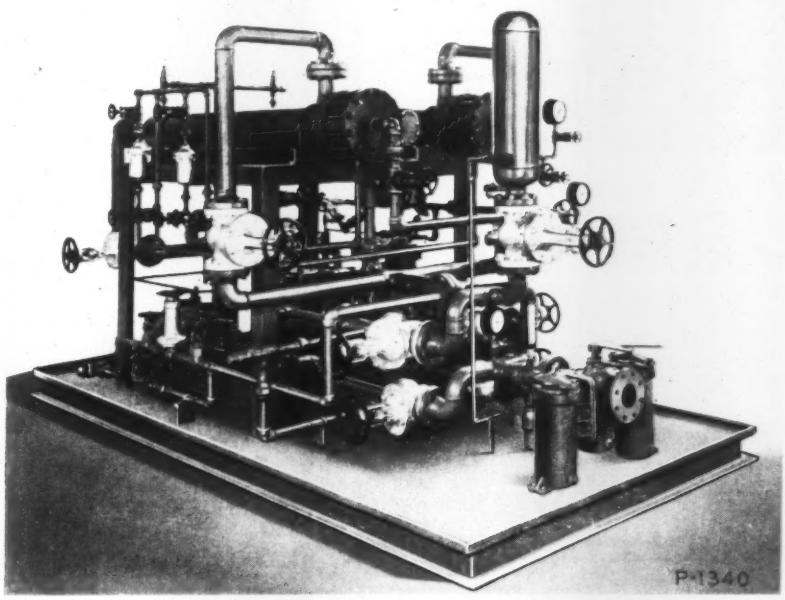
For example, these reliable, efficient units provide these advantages:

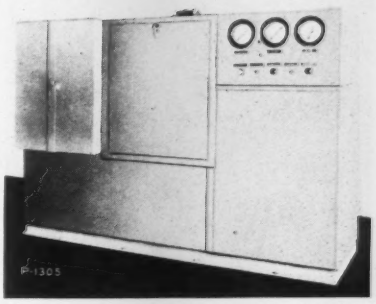
- even oil pressure and temperature
- valving easily understood by operators
- designed for a minimum pressure drop
- ease of maintenance
- space saving
- shipped complete ready for service connections
- less costly than on-the-job assembly



National Airoil Fuel Oil Pumping and Heating Units are available in single or duplex units, from 2 to 100 gpm in standard or special models.

Bulletin 40 contains the facts. May we send you a copy?



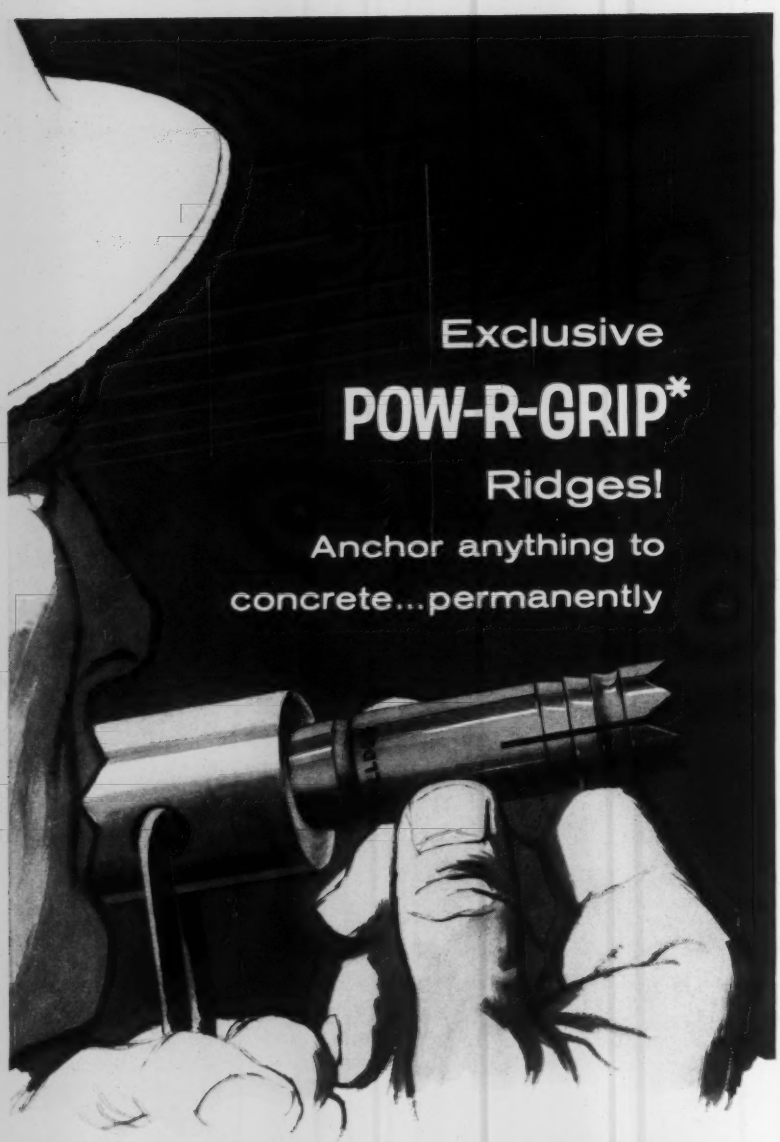


Now...National Airoil Automatic Packaged Firing Units

Here are truly automatic, economical, clean, and safe "packaged" firing units for oil and/or gas fuels. Equipped with the latest in electronic safety controls to give automatic start, automatic flame modulation, and automatic shutdown, these units are ready to go to work for you in a matter of hours. They require only oil, gas, steam, draft and electrical connections—everything else needed for fully automatic burner operation is furnished. Once installed, these National Airoil Automatic Packaged Firing Units will give years of satisfactory service with the lowest possible maintenance costs.

Capacities of standard units range from 200 to 830 boiler horsepower (7,200 to 30,000 pounds of steam per hour). Larger units are available on order to meet special needs.

Complete details, specifications, illustrations and dimensions are contained in Bulletin 28. We would be pleased to send you a copy. No obligation, of course. Write *today.*



BULLDOG
Gold Digger®

*POW-R-GRIP ridges around the shank of the BULLDOG "Gold Digger" drill/anchor permit *faster, easier drilling* into hardest concrete, brick or stone. Once the drill/anchor is set, these powerful ridges, plus the proven expansion principle of "Gold Digger" drill/anchors, assure greatest holding-power under all job and climatic conditions. Only POW-R-GRIP ridges assure "the grip that never fails".

Send for full details today!

BULLDOG DIVISION
(Formerly Polis Manufacturing Co.)
GREGORY INDUSTRIES, INC.
102-10 Toledo Avenue • Lorain, Ohio

Please send *free* specification and application booklet.

Name _____
Firm _____
Address _____
City _____ Zone _____
State _____

BULLDOG DIVISION, GREGORY INDUSTRIES, INC., 102-10 Toledo Avenue • Lorain, Ohio

3¾% interest
on New U.S. Savings Bonds now in effect

and the Bonds you already own are better than ever, too!

Now U. S. Savings Bonds are a better buy than ever in three important ways:

- *All Series E and H Bonds bought since June 1, 1959, now earn 3¾% interest when held to maturity.*
- *Older Bonds will also pay more—an extra ½%, from June 1 on, if you hold them to maturity.*
- *All Series E Bonds, old or new, now carry an automatic extension privilege; they'll keep paying liberal interest for 10 years beyond maturity.*

Three big new *dollar* benefits that make it smart to buy new Bonds—and hang on to the ones you have!

40 million Americans own Bonds

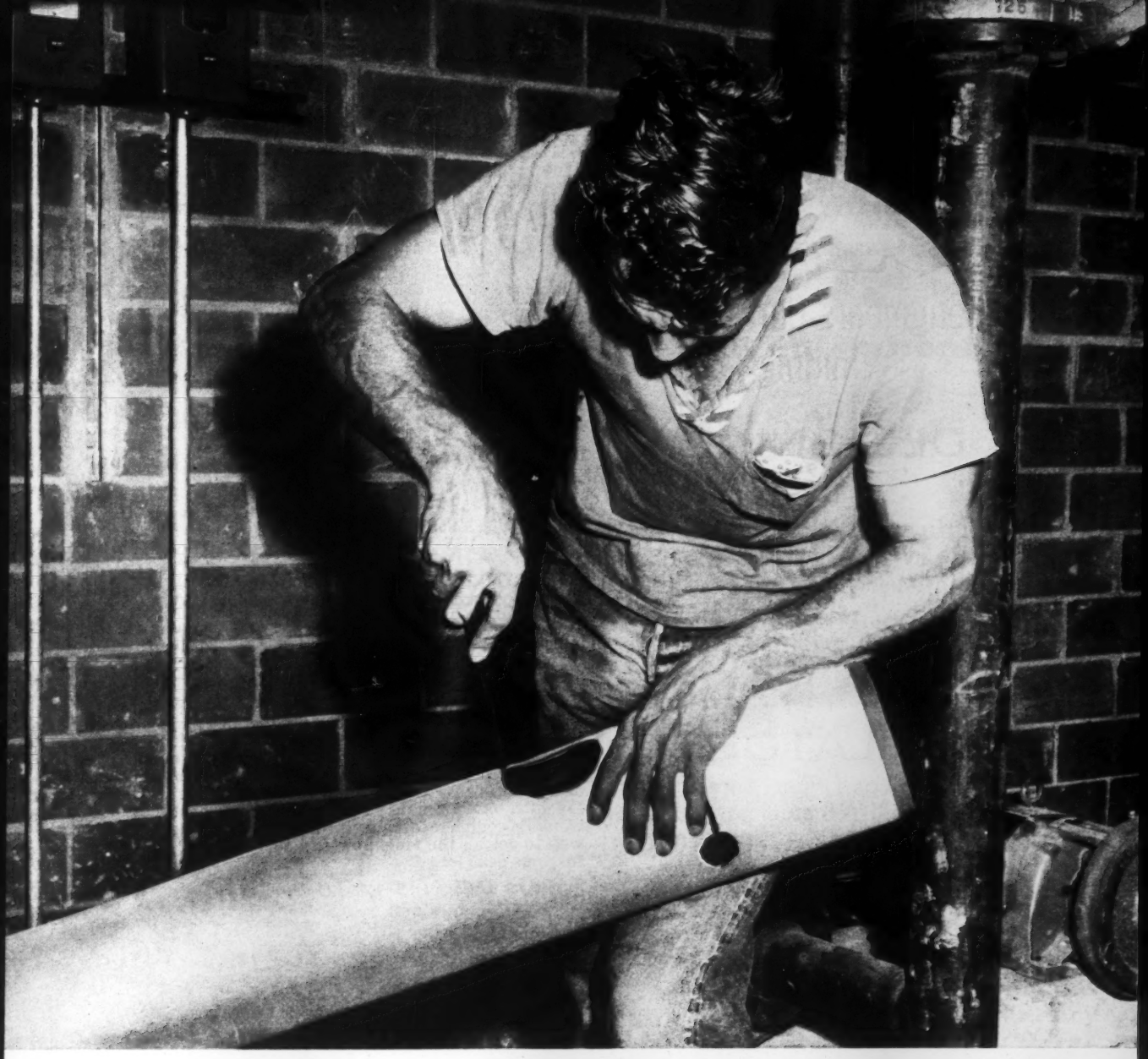
More people than ever own Bonds today. There's simply no easier, safer, more *American* way to save.

You can buy them through the Payroll Savings Plan at work; you can buy them where you bank. Either way, your U.S. Savings Bonds help build a more secure future for you, your family, and your country. And now they're better than ever!

HELP STRENGTHEN
AMERICA'S PEACE POWER

SAVE WITH U.S. SAVINGS BONDS

The U. S. Government does not pay for this advertising. The Treasury Department thanks The Advertising Council and this magazine for their patriotic donation.



He's also cutting costs ... with G-B SNAP*ON® pipe insulation

When applying insulation around obstructions, try this "short-cut": simply use G-B SNAP*ON, the one-piece pipe insulation molded of fine glass fibers. In just a matter of seconds, G-B SNAP*ON can be "tailor-cut" to fit snugly, neatly around runouts, feeders, valves, fittings, etc. And unlike brittle, rigid-type insulation materials that crack and break, G-B SNAP*ON is highly resilient . . . less susceptible to damage during installation. You'll be amazed, too, at how fast you can insulate straight runs, because 3′ and 6′ sections of G-B SNAP*ON snap over pipe in one quick, simple motion.

Add to these advantages the permanence and superior thermal efficiency of G-B SNAP*ON, and you can readily understand why it is industry's No. 1 choice for heated or cold lines. It's available from local stocks . . . plain or with a variety of facings for hot or cold lines, indoors or out . . . in sizes from copper tubing to 36″ IPS.

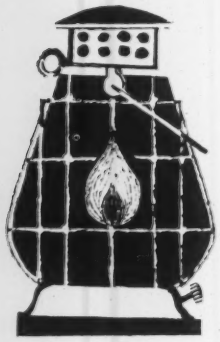
FOR INFORMATION & PROMPT DELIVERY
SEE YOUR G-B SNAP*ON DISTRIBUTOR
(LISTED IN THE YELLOW PAGES)

GUSTIN-BACON *Manufacturing Co* GUSTIN gb® BACON

220 W. 10th St., Kansas City, Mo.

Thermal and acoustical glass fiber insulations . . . molded glass-fiber pipe insulation
Couplings and fittings for plain and grooved end pipe

AT PENN
engineers burn the
midnight oil



DESIGNING
THE
BEST
IN
ROOF
VENTILATORS

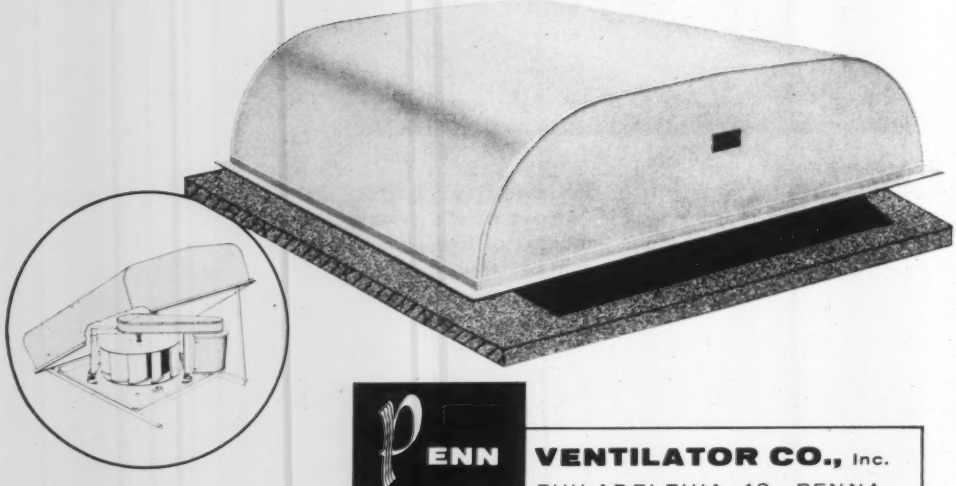
Penn's **LOW CONTOUR DYNAFAN**
cuts 50% off normal
roof exhauster heights

YET PROVIDES MORE ENGINEERING ADVANCES THAN MOST CONVENTIONAL VENTILATORS . . .

Low, streamlined and quiet is the Penn LC Dynafan . . . the industry's first major advance in a roof ventilator. Here is the one unit that helps engineers satisfy architectural demands for roof-top unobtrusiveness while providing advanced design characteristics.

The Low Contour Dynafan is a product of Penn's progressive engineering. Innovations such as side saddle mounting of motor parallel to the wheel reduced the unit's total height. Straddle mounting of bearings cut vibration and deflection. These and other important features in the LC Dynafan offer you a powerful exhauster that has been winning complete architectural approval. You would do well to get all the facts now and specify the LC Dynafan for your next job.

Write for Bulletin PD 42-LC



PENN **VENTILATOR CO., Inc.**
PHILADELPHIA 40, PENNA.

A leading manufacturer of Powered and Gravity Roof Exhausters and Accessory Equipment for over 30 years.

Representatives and Distributors in Principal Cities
Charter Member of AMCA

HEADROOM PROBLEMS

are but one of many reasons why leading gas companies now recommend a

for commercial-industrial GAS equipment

Proven in thousands of gas installations, Field does everything a draft diverter does—AND MORE—offering new simplicity, new flexibility, new precision in the control of draft.

Here's how Field helps make **GAS** an even finer fuel:

1 — **COMPACT SIZE: Field** is small, compact, can be placed in a variety of approved locations. Limited headroom no longer presents a draft problem.

2 — **DRAFT ASSISTANCE:** With **Field** you can utilize the draft assistance of the chimney, with settings as low as .002", as high as .35". Draft-short installations are avoided.

3 — **LOAD FLEXIBILITY:** With a **Field** firing rates can be varied — increased for increased loads, or decreased, and without loss of efficiency. Now gas is an even more flexible fuel.

4 — **REDUCED CONVERSION COSTS:** With a **Field** no change in breeching area is required when converting from coal or oil. Now it is quicker, simpler, less costly to convert to gas.

5 — **REDUCED "START-UP" SPILLAGE:** by avoiding loss of chimney prime, permitted with a diverter, **Field** minimizes the spillage caused by cold stack resistance.

6 — **AUTOMATIC CONTROL: Field** not only gives visual evidence of any spillage, but, when switch-equipped, spillage will automatically actuate virtually any response an engineer may specify. Thus **Field** permits still another refinement in the industry's meticulous handling of its fuel.

If you design, specify, install or approve gas-fired equipment consult Field engineers for draft control recommendations.

FIELD CONTROL DIVISION

Conco Engineering Works, Inc., Mendota, Illinois

AFFILIATES:

Spartan Tool Division — Powered Sewer Cleaning Equipment
Materials Handling Division — Cranes, Hoists
Conco Building Products, Inc. — Brick, Tile, Stone

field

Mr. Frank Flick, President, Flick-Reedy, Bensenville, Ill., says:

"Even this huge heat pump went smoothly with

Mr. Frank Flick, President, Flick-Reedy, and Mr. Zay Smith of Zay Smith and Associates; Architects and Engineers, LaGrange, Illinois.

control installation
Honeywell men on the job!"

Wall-mounted thermostats in every private office enable employees to dial the exact temperature they prefer. And in each of the buildings' working spaces, strategically placed thermostats assure comfort no matter what the activity.

Honeywell Engineers working on the air conditioning system at the distinctive new Flick-Reedy power cylinder plant, installed the exact control system needed for one of the world's largest heat pumps!

"The job of harnessing this huge heat pump was mighty important to us," says Mr. Flick. "Our plans called for a customized temperature control system which would assure the welfare of our employees, and solve certain critical production problems. It was a large order, but Honeywell Engineers, working with the York people and Zay Smith and Associates Engineers, solved the problem to our complete satisfaction."

Air conditioning this 220,000 square foot plant presented some unusual problems. The entire work area is fully air conditioned—including the welding, heat treat and plating areas. And, the entire system is completely automatic. A Honeywell Supervisory DataCenter* (shown in background) monitors the heat pump and controls temperatures in every zone.

In addition, every private office and conference room is equipped with its own Honeywell Round thermostat.

As the leader in temperature control for 75 years, Honeywell is well equipped to help you solve your clients' most critical temperature control problems. Call your nearest Honeywell office today. Or, write Minneapolis-Honeywell, Minneapolis 8, Minn.

Trademark

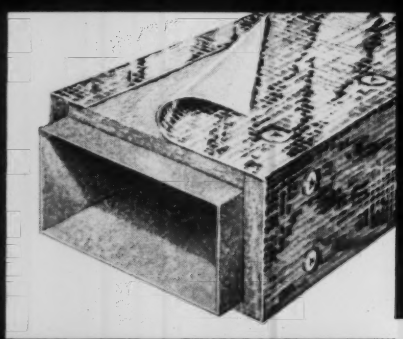
Honeywell

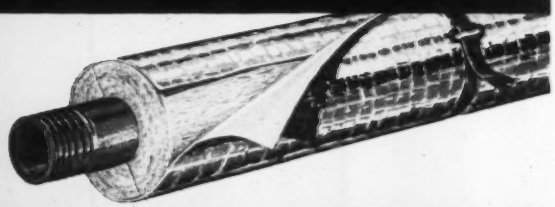
H HONEYWELL *First in Control*

SINCE 1885

75th YEAR PIONEERING THE FUTURE

PYRO-KURE*





An improved line of flame resistant vapor barriers for insulation facing, duct lining, pipe jacketing

Offers these superior properties:

- *Permanently non-combustible*
- *UL flamespread rating — under 30*
- *Perm rating less than 0.1*
- *Stronger for no-tear application*
- *Better textures for best appearance*

Pyro-Kure vapor barriers will up-grade the insulation with which they are combined. A unique manufacturing development provides *permanent* flame resistance. The adhesive used for laminating the multiple plys of kraft, foil or plastic film and the reinforcing fibers emits a gas at combustion temperature. This gas will snuff out the flame when the ignition source is removed. These products, then, are self-extinguishing.

Pyro-Kure vapor barriers are available in various combinations and standard widths. All of them provide excellent protection against condensation and at a cost equal or below similar vapor barrier material which is still not permanently flame resistant.

Leading insulation manufacturers are now combining Pyro-Kure with their products. For your guarantee of the best, specify "Pyro-Kure."

Write Dept. HP1 for more facts on this new vapor barrier line.

*Patent Applied for.

SISALKRAFT

AMERICAN SISALKRAFT CORPORATION
Chicago 6 • New York 17 • San Francisco 5
In Canada: Murray-Brantford Ltd., Montreal

reinforced paper, foil and plastics for construction, industrial packaging and agriculture

HUSKY TAKES THE TURNS

HUSKY
WELDING FITTINGS

—with strength to spare!

A WIDE MARGIN OF SAFETY

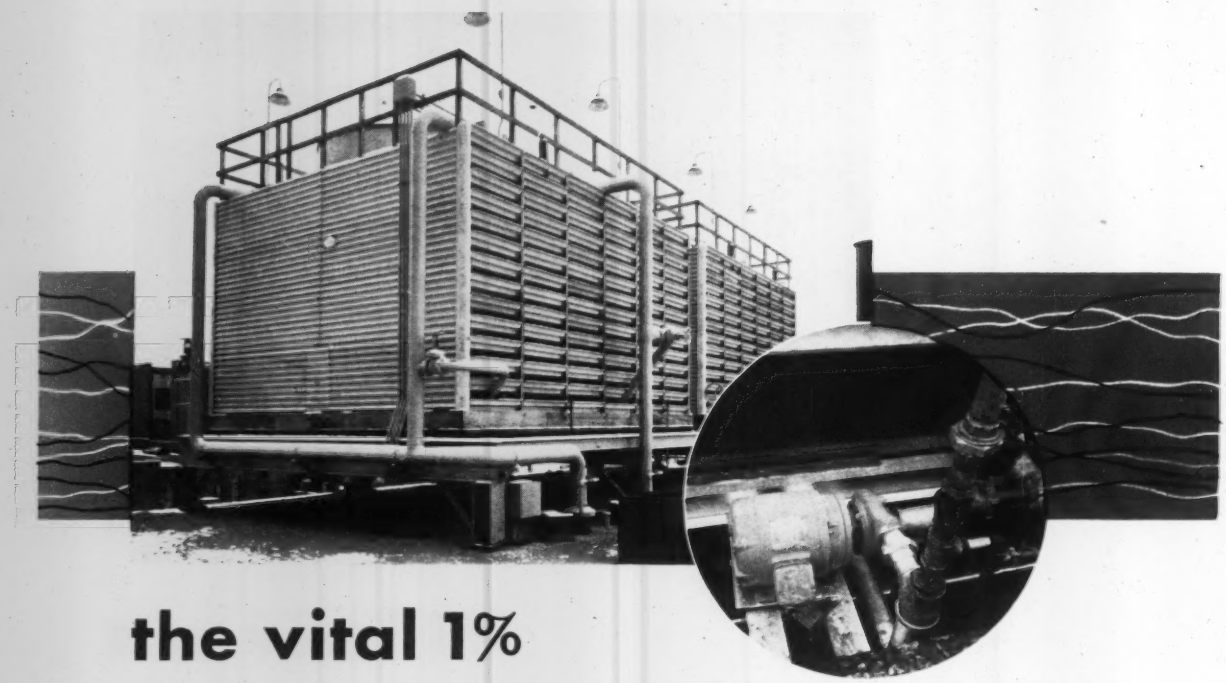
Unretouched photo at left shows that a HUSKY 4" elbow has more than *eight times* as much strength as needed . . . even when Schedule 40 pipe is used at its maximum recommended working pressure. The pipe burst at 7,750 p.s.i.—but notice that our HUSKY elbow is still intact!

Perhaps even more important than its super strength is the HUSKY price, a 4" elbow like the one shown costs about two-thirds as much as a regular specification elbow! HUSKY is the only steel welding fitting made specifically for low pressure piping. *Write for catalog and prices.*

The unique shape of the HUSKY elbow is shown here. It results from cold-flow working which compacts the metal for enormous strength, while still maintaining the minimum wall thickness specified for Schedule 40 pipe. Note, also, the heavy build-up of metal in the crotch of the elbow . . . the point of greatest stress in piping.

STEEL

NIBCO INC., Dept. KS-6403 Elkhart, Indiana



the vital 1%

In an air conditioning installation, the pump seldom exceeds 1% of the total cost, but the importance of this 1% is obvious . . . if the pump breaks down, the entire system fails. The proven dependability and lower maintenance costs of Ingersoll-Rand Motorpumps are only two reasons why they are the leader for such important applications. I-R Motorpumps simplify installation because they are compact. They operate in any position and they are available in a wide range of types and sizes to meet any requirement.

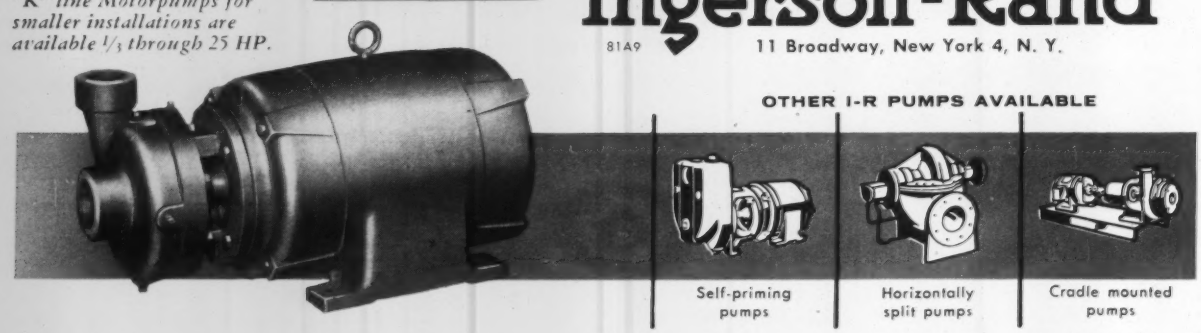
a century 1860 – 1960 *of pump progress*

from the leading manufacturer . . .

Ingersoll-Rand

81A9 11 Broadway, New York 4, N. Y.

"K" line Motorpumps for smaller installations are available 1/3 through 25 HP.



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The Tee Turner works equally well in the shop or on the job. It saves literally hundreds, even thousands of dollars on big jobs by (1) eliminating the need for reducing tee fittings, and (2) reducing the number of solder joints at each branch from 3 to 1. Cuts labor costs on tubing installations up to 75%!

The Tee Turner has been approved and specified for branching by consulting engineering firms all over the U.S. It has been used in the construction of schools, hospitals, motels, industrial plants, commercial buildings, and residences. In addition, it has proven ideal for remodeling and maintenance work in large plants and commercial buildings.

This tool is already being used by plumbers and mechanical contractors in Boston, Metropolitan New York, Newark, Miami, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, St. Louis, Dallas, Denver and Los Angeles.

Tee Turner tools are available for both water distribution and drainage systems. For complete information fast, write, wire, or mail coupon to *The Erie Tool Works, Dept. C-3, Erie, Pennsylvania.*

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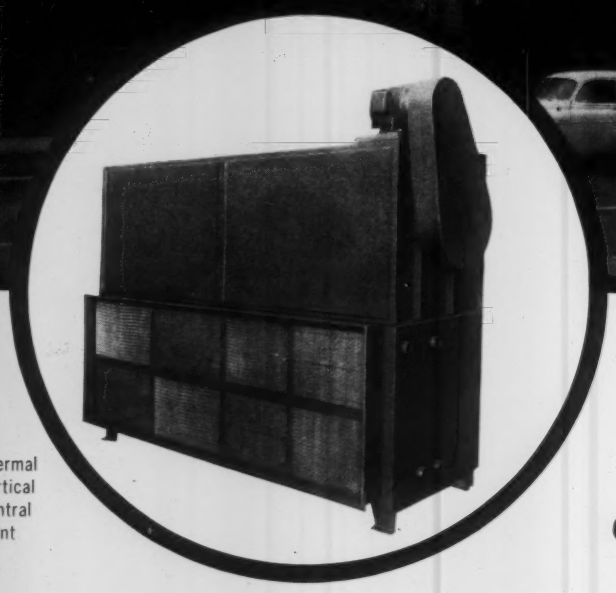

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The Thermal line of finer equipment includes central and multizone conditioners, sprayed coil units, heating and ventilating units, heating and cooling coils, and air-cooled condensers. Types and sizes of all units are available to meet the architectural requirements of all kinds of buildings and weather conditions.

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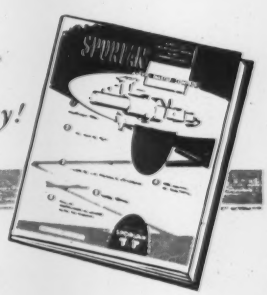

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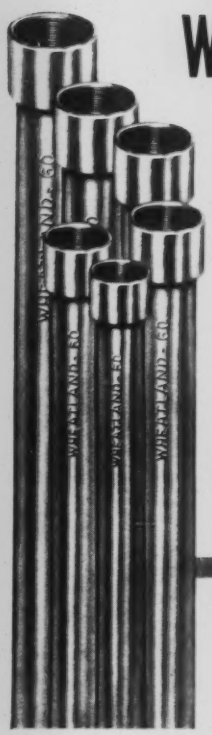

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Now, with new "SCOTCH" Brand Pipe Sealant Tape No. 547, you can stop fitting leaks quickly . . . easily . . . permanently! And, unlike conventional "pipe dopes", it rolls on dry; a single wrapping around the threads *does the job on any line.*

This new all-purpose sealant for your piping systems is chemically inert; withstands processing temperatures from the liquid oxygen range on up through super-heated steam; is not affected by traces of oil or other lubricants in the steam lines.

Tape No. 547 is easy to use, too! Handy roll size fits any pocket; can be applied anywhere; conforms tightly; any excess strips off easily to leave a neat, clean joint. What's more, it never dries out . . . permanently lubricated joints never stick; open with ease during line re-positioning.

Ask your nearest "SCOTCH" Brand Tape distributor for complete information, or write: 3M Co., 900 Bush Ave., St. Paul 6, Minn., Dept. IAT-30.

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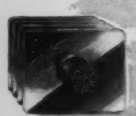
...a Low Silhouette Blower Condenser that offers high performance and exceptional installation flexibility



Inner-Fin Construction

The shape of the Dunham-Bush 'LSBC' really has a function . . . the low lines of this new air cooled blower condenser give it an important application/installation superiority over similar units of different design.

Because its new engineered shape ensures safe pounds-per-square-foot loading, the 'LSBC' can be installed virtually anywhere on any roof, without the costly reinforcement of roof members usually necessary to support heavier units. And, the low, compact 'LSBC' is easily accommodated within minimum space, yet has the operational and construction features to meet the most rigid performance demands. Air movement is up and out, meaning minimum noise rating.

Other major features include a high efficiency inner-fin condenser coil with less internal volume and therefore smaller refrigerant charge . . . drip-proof, NEMA frame, grease-lubed ball bearing type motors, with an adjustable base to facilitate belt tension adjustment.

The 'LSBC' is available in a variety of circuits. Models range from 5 to 53.5 tons.

For further information, write for Form No. 7011-1, or call the Dunham-Bush sales engineer near you.

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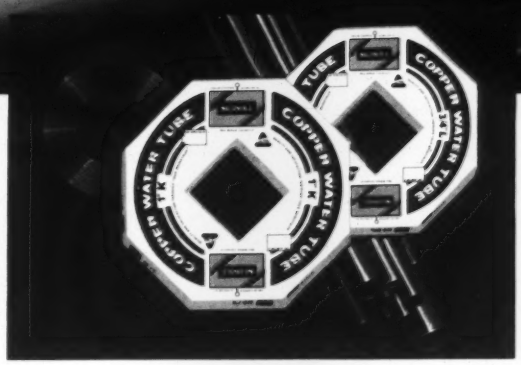

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Scovill Copper Drainage Tube (DWV) also simplifies stocking, cuts with less waste, saves you time and money all the way. It is being approved by more and more architects, builders and code authorities every day for quality installations. It's one of the fine new product trends in building *you* should be following now.

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. . . the bite of the ice pick splitting a block of ice . . . the clank of tongs . . . the heave of the ice cake to the iceman's soaking shoulder apron? Remember his dripping trail up the walk, across the porch and kitchen to the icebox? What an appetite it had for cakes of ice . . . remember? And "mop up those tracks . . . don't forget to empty the drip pan!"

While the iceman made his rounds years ago, scientists worked to perfect a safe refrigerant. In 1931 development of "Freon" refrigerant opened the door to progress that has put safe, efficient, carefree refrigeration into nearly every home in the country. Today, "Freon" stands first for quality and leadership in serving the refrigeration and air conditioning industries.

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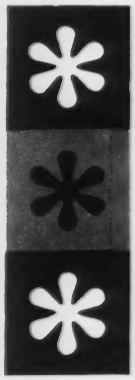


ASHRAE To Develop New Psychrometric Chart

FOLLOWING the psychrometric chart symposium held at the recent semiannual meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers in Dallas, the ASHRAE technical committee on Psychrometrics met and agreed that a new chart should be developed. It was decided that the new chart should consist of a series of isobaric charts with the pressure differences to be determined after study. It was also concluded that the new chart would be developed around the variables of "humidity mixing ratio" as the ordinate and "enthalpy" as the abscissa. With values for these parameters as the coordinates, the wet bulb and dry bulb temperature lines will be at right angles to each other, thus increasing the simplicity and accuracy. These conclusions were reached after the following speakers had expressed their views in the symposium on this subject:

a) R. W. Haines, Bridgers & Paxton, consulting engineers,
b) Professor J. L. Threlkeld, University of Minnesota,
c) Professor J. A. Goff, school of mechanical engineering, University of Pennsylvania,
d) C. M. Ashley, chief staff engineer, Carrier Corp., and
e) D. D. Wile, vice president and chief engineer, Recold Corp.

Mr. Haines expressed his need for high altitude charts because of the increasing number of air conditioning installations in the areas of New Mexico, Arizona, Utah, and Colorado at elevations from 4000 to 8000 ft. He has found the present ASHAE psychrometric chart for sea level conditions to be inadequate. Mr. Haines showed three charts for altitudes of 3850, 4900, and 6900 ft which he had prepared using the data from the Goff and Gratch tables in the 1955 edition of the Guide, Chapter 3, Tables 2 and 3.

Professor Threlkeld presented a new psychrometric chart which provides for the solution of air conditioning problems for barometric pressures from 10 to 14.696 psia and over the temperature range of zero F to 120 F. The chart is of the Mollier type with the coordinates of "humidity mixing ratio" and "enthalpy." This new chart also includes information on wet bulb and dry bulb temperatures, relative humidity, and volume.

Professor Goff emphasized the need for the psychrometric chart to be thermodynamically consistent within the accuracy of the data available. He, too, suggested a new chart be developed with the coordinates of "humidity mixing ratio" as the ordinate and "enthalpy" as the abscissa. He also suggested that the new chart should consist of a number of isobaric charts for a range of altitude conditions. Professor Goff also reported that the International Society of Meteorologists was studying the definition of the term "relative humidity" and that this group preferred the term "degree of saturation" to be more consistent and meaningful.

Mr. Ashley pointed out that the psychrometric chart should meet the following qualifications:

a) That it be easy to understand and that it can be used to explain processes clearly,
b) That it be easy to use,
c) That it be thermodynamically correct with no compromises,
d) That it be as complete as possible, showing dry bulb temperature, wet bulb temperature, relative humidity, humidity ratio, effect of

barometric pressure, and that there be no question in solving problems with it.

Mr. Ashley stated that neither the ASHAE nor the ASRE chart fully meets these requirements, so he felt that a new chart should be developed to meet these conditions.

Psychrometric charts from the user's viewpoint was discussed by D. D. Wile. He suggested that the Society prepare a new chart, one for the low temperature range, and one for higher temperatures. He felt that the chart should be 8½ by 11 in. in size, one color, suitable for blueprinting, and made available in pads in order to encourage wide use.

I. D. Tags Speed Refinery Maintenance

CLAMP-ON identification tags are used at the Union Oil Co. refinery in Wilmington, Calif. to aid maintenance crews in isolating units of the piping system for inspection and repair.

The tags are painted with identifying numbers or symbols corresponding to instructions furnished the service crews, then clamped to the pipe lines near the flanges that are to be disassembled. Solid plates are inserted into the flanges for personnel safety. Upon completion of the repair, the tags are removed and repainted to identify the next unit requiring maintenance.

Use of the tags helps to insure quick and safe completion of the various steps in the refinery's continuing maintenance program, according to Marman Div., Aeroquip Corp.

Movable Dome Stadium To Be Air Conditioned

THE new Public Auditorium being built in Pittsburgh, which incorporates the largest movable dome ever designed to convert it from an open air stadium to a closed auditorium, will be completely air conditioned, according to The Trane Co.

The 415 ft diameter dome, which rises to a height of 136 ft, can be closed automatically to inclement weather in 2½ minutes. When the dome is closed, all public spaces within the structure will be supplied with conditioned air.

The system is designed for four-part, automatic control from the main equipment room. Monitoring and adjustment for all spaces can be carried out from a single control center, where the engineer on watch will be able to obtain temperature readings from a number of points on each level of the building.

Two main outdoor intakes are located on the northwest and southwest faces of the building on the first level. Outdoor air will be drawn in through louvers, passed through automatic filters, and be drawn through two main 14 by 12 ft tunnels beneath the exhibit floor, then carried by four risers to the various equipment rooms for conditioning.

While the auditorium rises above the ground as high as a 12-story building, much of this is air space. There are three working levels to the structure.

The lowest level of the stadium contains 50,000 sq ft of exhibition space, which is to be cooled by means of a 200 hp centrifugal compressor. Meeting rooms on the first and second levels will utilize a reciprocating water chiller, with a similar but smaller unit serving the office areas. The main arena, which comprises the top level of the structure, will employ a 900 hp centrifugal compressor unit to discharge 280,000 cfm of conditioned air through eight fan-coil equipment rooms to the arena via peripheral pylons.

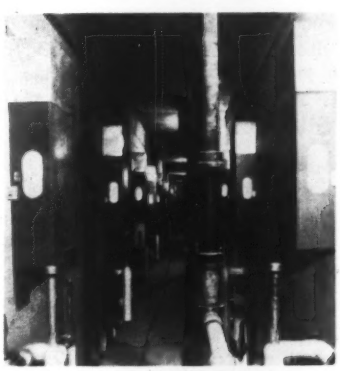
The total cooling capacity of this high pressure system will be 1200 tons. The mechanical cooling equipment will be installed by Limbach Co.; consulting engineers for the installation are John W. Mullins and Associates, all of Pittsburgh.

Four Zone Heating Feature of New School

THE NEW Eisenhower elementary school in Gettysburg, Pa., was recently dedicated in honor of President Eisenhower. The new school has two wings and each is a separate heating zone. In addition, a 230-pupil cafeteria and a 300-seat multi-purpose auditorium are each zoned separately. This arrangement allows either wing or either of the two major rooms to be used outside of school hours without raising the temperature of the entire building.

Two 1-1/3 million Btu per hr packaged automatic boilers are capable of delivering 1400 lb of steam per hr to the four zone building at a pressure of 4 to 5 psi. They are equipped with combination burners for light oil or gas operation.

One boiler will carry the entire load except in extremely cold weather, according to Boiler Engineering & Supply Co., Inc. Thus, alternate operation of the units is possible.



Sound Traps Thwart Prison "Grapevine"

INDIVIDUAL SOUND TRAPS, installed within the ventilation ducts at the new Salem, Ore., Correctional Institution have ended a prisoners' practice of using the ducts to carry verbal and written messages and information between cells.

During the planning stages for the new building, state prison officials asked the architectural firm of Amand, Boone, & Lei and consulting engineer W. Bruce Morrison to design the ventilating ducts so air would flow properly but would not carry sound. The solution centered around the decision to install 261 sound traps in the duct system — one behind each cell.

Prison superintendent P. J. Squier says the system has proved to be most effective in operation.

Similar traps have been used in duct systems for recording and broadcasting studios and in other buildings where ventilation noise has been objectionable, according to Koppers Co., Inc.

New Law to Control Chicago Air Pollution

UNDER the provisions of an amendment to an existing city ordinance, Chicago's control of the air pollution problem should be increasingly effective in 1960, according to Thomas H. Carey, director of the air pollution control department.

Auxiliary boards which have been established in accordance with the amendment include an air pollution control committee, to which nine representatives of industry have been appointed, a technical advisory board, an analytical laboratory, and an appeals board to administer the ordinance. More than half a million dollars has been approved for the work of the department for the current year.

Test figures for the month of September 1959 show that the city had an average dust fall (dust, dirt, and smoke) of 31.8 tons per square mile during that period.

Plastic Duct System Solves Corrosive Hood Problem

SINCE the fumes from chemical operations performed under laboratory hoods are usually extremely corrosive, the selection of duct materials presents a difficult problem. So it was for the duct system in the new University of Buffalo Science and Health Building.

In this installation it was imperative that the duct system afford complete corrosion control, since a false ceiling will be added to cover the ducts and other services. The material selected for this application was resin bonded glass fiber sheets. The material is homogeneous and is equally resistant to attack both inside and out, according to Du Verre, Inc.

The installation was made by Buffalo Sheet Metals, Inc. Jones, Meadows, & Howard were the architects and engineers.

Professor O'Bannon Honored by ASHRAE Life Members

AT THE recent semiannual meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers in Dallas, Professor Lester S. O'Bannon of the Mechanical Engineering Department, A. and M. College of Texas, was given an award of merit in recognition of "outstanding work in teaching and advancing the principles of the industry and profession." The nomination for this award came from the Life Members Club and was approved for the national organization by the Honors and Awards Committee.

This was the third such award made by the Life Members Club of the Society. Previous awards were made to Professor Linn Helander of Kansas State College in 1958, and to Professor Merl Baker of the University of Kentucky in 1959.

Professor O'Bannon's association with the Society began in 1922 when he worked at the Society's research laboratory while on leave from the University of Kentucky. A graduate of the University of Kentucky, he began teaching there in 1920 as Assistant Professor of Steam Engineering. Later he was promoted to Professor of Heat-Power Engineering, and in 1935 he became Head of the Department of Mechanical Engineering. From 1936 to 1946 he was Research Mechanical Engineer for the Kentucky Agricultural Experiment Station.

He was Research Engineer and Visiting Professor of Mechanical Engineering at the University of Michigan from 1946 to 1948. He went to Texas A. and M. College in September 1948. He is a member of the Houston Chapter of ASHRAE and until recently was sponsor of the Texas A. and M. College Student Branch.

While teaching at the University of Kentucky between 1920 and 1935 Professor O'Bannon worked under the direction of the late Dean F. Paul Anderson as a research investigator in the field of heating and air conditioning. His pioneer experiment on the simultaneous flow of water and air in pipes supplied information for the code committee on pipe sizes for steam heating systems.

Professor O'Bannon says that he is a living denial of advice he gives his students; that is, to specialize. He says the only thing he has specialized in is non-specialization. The list of equipment he has tested or used in various investigations — ranging from open hearth steel furnaces, boilers, and engines to fuels, lubricants, tobacco, and human comfort — reads like "the index of a mechanical catalog."

Professor O'Bannon is also a life member of the American Society of Mechanical Engineers. Other organizations of which he is a member are American Association of University Professors, American Society for Engineering Education, Texas Association of College Teachers, Sigma Xi, Tau Beta Pi, Alpha Sigma Phi, and Phi Mu Alpha.

ASHRAE Elects New Officers at Dallas Meeting

NEWLY ELECTED OFFICERS of the American Society of Heating, Refrigerating and Air-Conditioning Engineers who accepted their positions for 1960 in Dallas are:

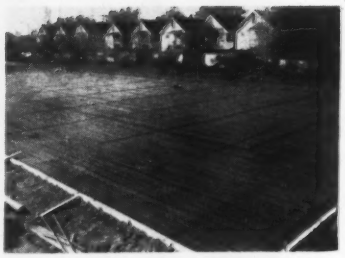
President, D. D. Wile, vice president and chief engineer, Recold Corp.

First vice president, W. A. Grant, vice president, Research and Development Div., Carrier Corp.

Second vice president, R. H. Tull, Westinghouse Electric Corp.

Third vice president, John Everetts Jr., consulting engineer, Charles S. Leopold firm.

Treasurer, F. Y. Carter, manager, market planning, Detroit Controls Div., American Standard.



Zone Piping Controls Melting on New Ice Rink

A PIPING SYSTEM that permits the direction of brine flow to be shifted so as to compensate for spot melting has been incorporated in two new Cleveland, O., artificial ice rinks, according to Jones & Laughlin Steel Corp.

The two rinks, each 185 × 85 ft, together required 100,000 ft of steel pipe, installed in 180 ft lengths and connected to 3½ in. headers at the ends of the skating area. To provide an even ice temperature, each rink is divided into four zones of 64 pipes each, in which the brine flows in alternate directions. More brine may be directed to any fast melting spot by a special reversing valve.

Each 1000 gpm system is embedded in reinforced concrete on a gravel and clay bed. The piping systems and refrigeration equipment were installed by Smylie Brothers Refrigeration, Inc.

PVC Used for Aqueous Slurry Piping

EXPERIMENTS were recently conducted in a Massachusetts experimental laboratory involving the use of ¾ in. diam Type I PVC piping as an aqueous slurry carrier.

The line carried aqueous slurry of 70 percent sandstone, 100 mesh, for 2500 hours. During 500 hours of this test period, the sandstone was in a 5 perecnt sulfuric acid solution instead of water. Operating temperatures ranged from 40 to 85 F. Examination of the straight and 45 deg bend sections revealed no visible deterioration after this period of time.

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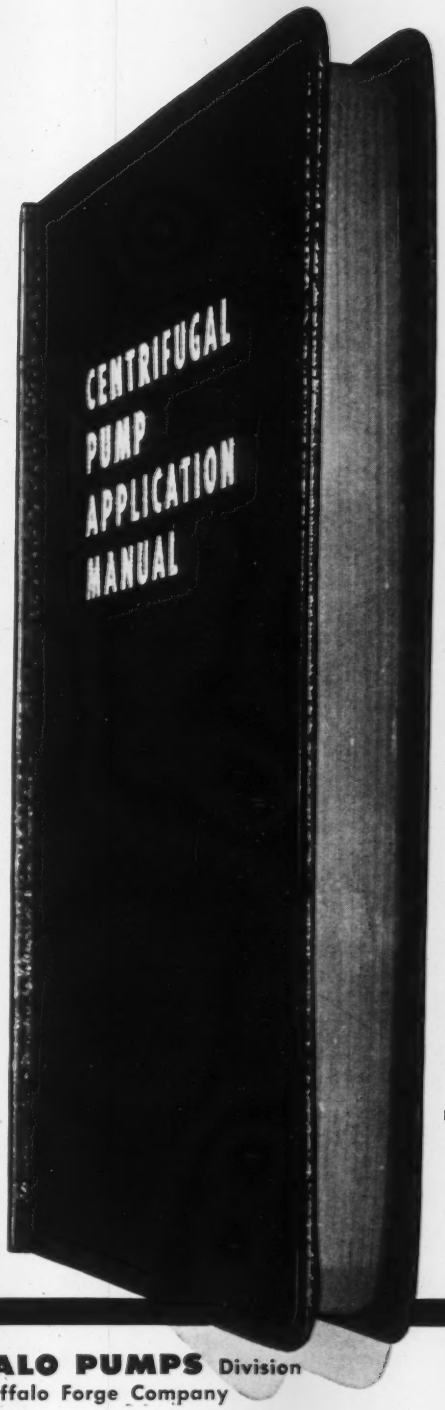

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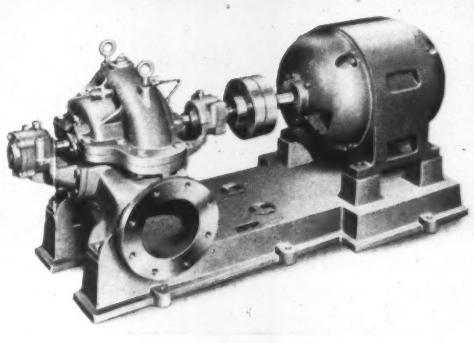

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City_____ Zone____ State_____

In the Chicago area you'll find hundreds of Arkla-Servel Sun Valley Gas air conditioners in food stores, drug stores, general stores, restaurants, taverns, halls, beauty parlors, medical centers, business offices, service offices, plant offices, small factories, small shops, repair shops, barber shops, branch offices... bringing year 'round comfort to customers and employees.

more and more Chicago businesses are cooling with GAS! Many Chicago firms need a compact, automatic unit that will both heat and cool at low cost. That's why – in a one year period – 275 Arkla-Servel Sun Valley Gas air conditioning units were specified and are being used in business places throughout the Chicago area.

With this central Gas unit, there's no need for fans, window air conditioners or separate cooling units. The design is so clean and simple that it can be installed wherever there is room... out in the open, on the roof, in the basement, or in the back room.

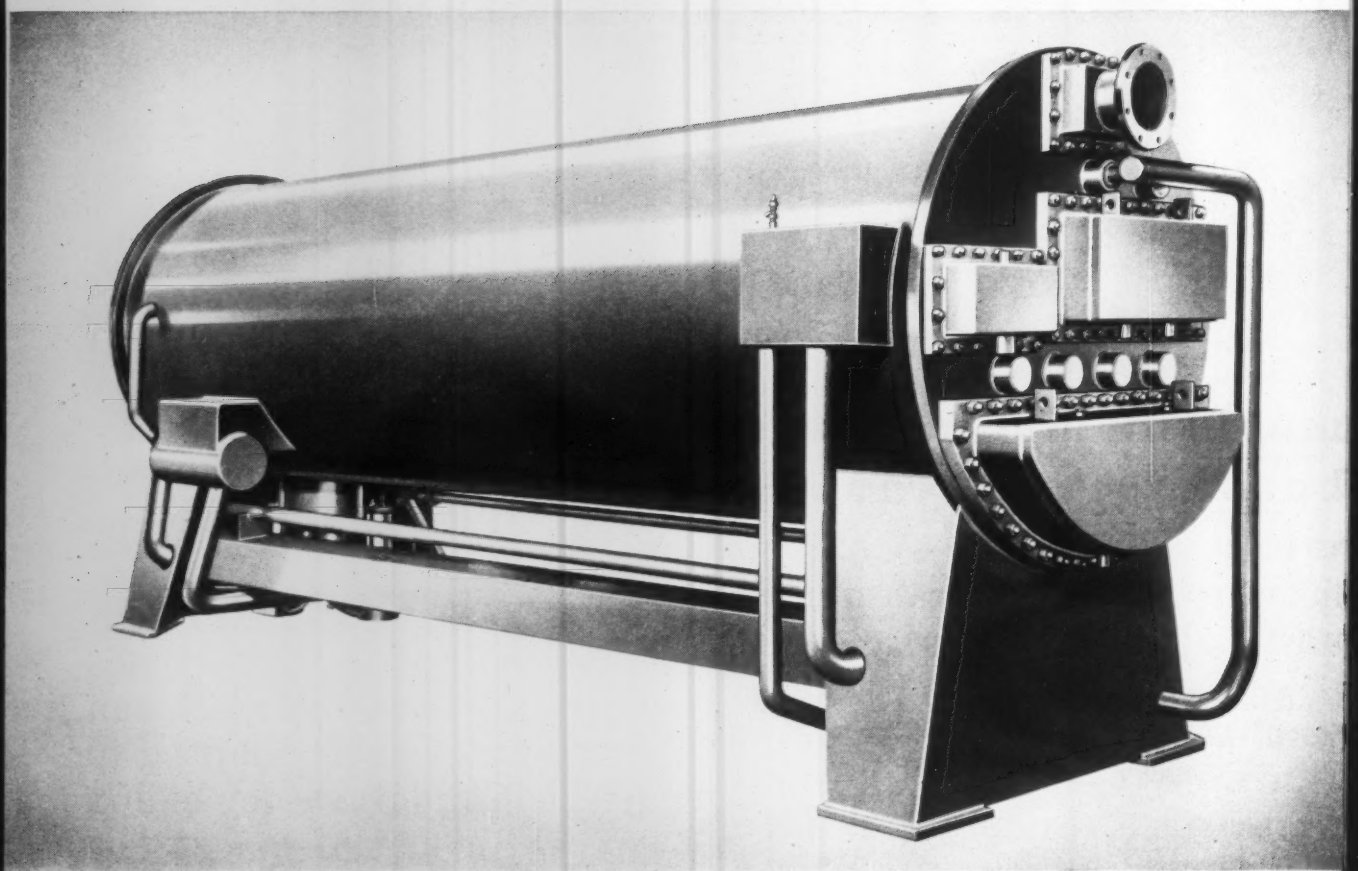
In addition to heating and cooling, the Arkla-Servel Sun Valley unit also cleans the air, dehumidifies and ventilates to assure year 'round comfort.

The Arkla-Servel Gas air conditioner is flexible, too – comes in 3½ and 5-ton units which can operate singly or be adapted to multiple installations depending upon the amount of space to be air conditioned.

If your customers and employees sweltered this summer, think now about installing a Gas cooling system before next year's heat wave is here. For specific information, call your local Gas company or write to the Arkla Air Conditioning Corporation, General Sales Office, 812 Main St., Little Rock, Ark. AMERICAN GAS ASSOCIATION

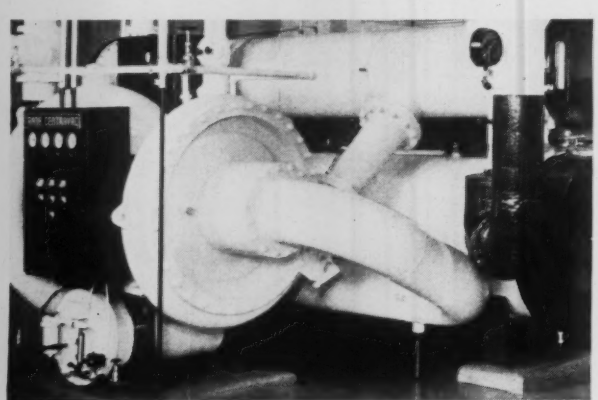
FOR HEATING & COOLING GAS IS GOOD BUSINESS

Now! Low-cost industrial Trane Hermetic

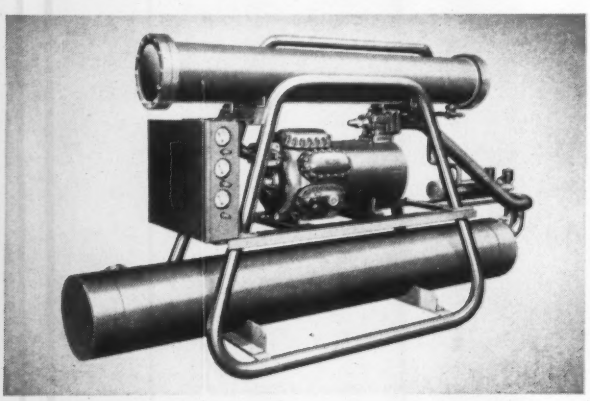


For industrial process cooling or comfort air conditioning—wherever there is a supply of low-cost steam—the new TRANE Absorption Cold Generator is available in nine sizes, 100 to 350 tons . . . making it easy to select a unit to match the exact requirements; means fuel savings and efficient part load operation.

There's Trane matched equipment for every air conditioning need...



Hermetic CenTraVac water chiller with electric drive modulates to 10% of capacity, or lower, with power savings in almost direct proportion to load. Compact, with low silhouette design. Open type compressor models for any type of drive and steam turbine CenTraVacs are available.



New Reciprocating Cold Generator now hermetic—with TRANE built chiller and condenser. Provides efficient water chilling for a wide variety of applications. Factory-wired control panels mounted on unit to eliminate on-the-job wiring. Features new TRANE Hermetic Reciprocating Compressor.

water chilling...with a Absorption Cold Generator

Advanced hermetic design, single-shell construction provide simplified installation, minimum maintenance, economical operation for process or comfort cooling

Here's a compact packaged hermetic absorption water chiller—the TRANE Absorption Cold Generator. It's designed to provide a dependable, economical source of chilled water for process or comfort cooling in industrial plants, hotels, apartments and office buildings—wherever there is a supply of steam or hot water.

The advanced *hermetic* design assures reliable operation under all operating conditions . . . prevents air from entering the system which causes crystallization, deterioration and maintenance problems. The machine operates under conditions which avoid crystallization. (If power failure or other temporarily abnormal conditions occur, the machine will tend to free itself of any resulting crystallization.)

Fully automatic operation means no full time attendant is needed. The unit responds immediately and automatically to changing load requirements. Its design provides maximum efficiency under full and partial load conditions—results in low power consumption, economical operation. And the new Absorption Cold Generator is *quiet*, vibration-free—may be located anywhere without sound-proofing the area. Single-shell construction reduces overall size, permits installation in areas with low ceilings. Factory-assembled and wired, it has been designed to effect substantial savings in installation time and costs. Nine sizes from 100 to 350 tons permit selection of a unit to match the exact cooling requirements.

The TRANE Company has extensively tested and proven this new *hermetic* absorption water chiller design assuring dependable, economical water or other liquid chilling for a wide variety of applications; and it will minimize operation and maintenance problems.

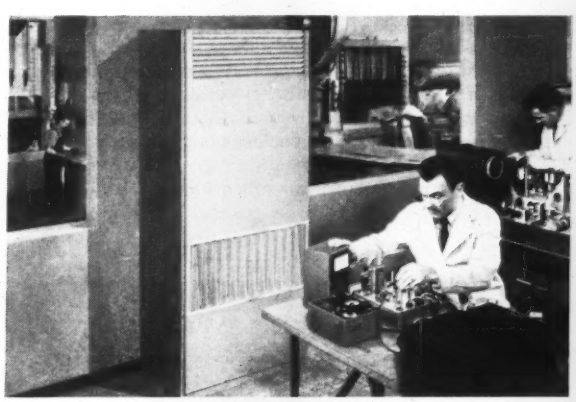
WANT MORE FACTS? For complete information on the new TRANE Hermetic Absorption Cold Generator, just call your nearby TRANE Sales Office; or write TRANE, La Crosse, Wisconsin.

For any air condition, turn to

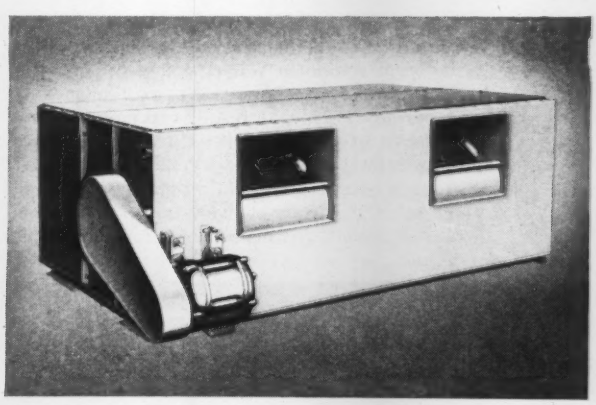
TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING,
HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

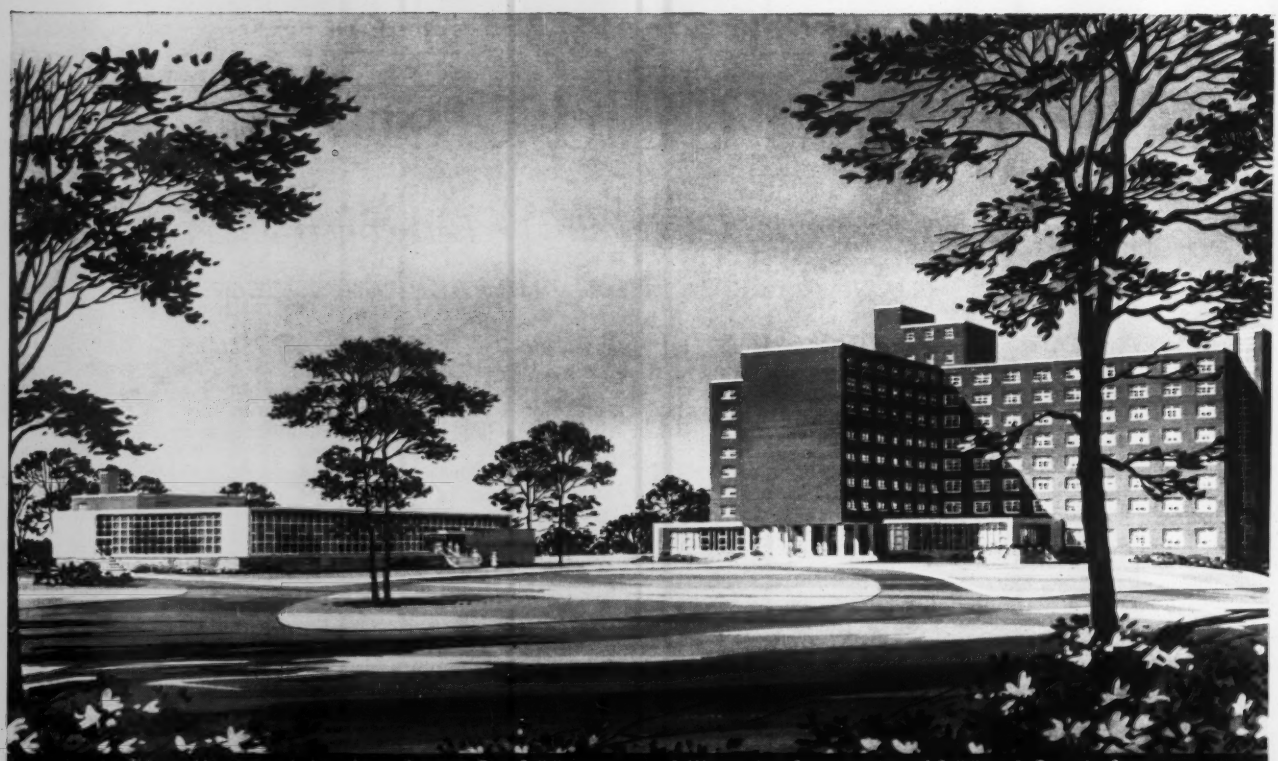
THE TRANE COMPANY, LA CROSSE, W.S. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U.S. AND 19 CANADIAN OFFICES



New Heat Pump is compact, efficient, designed for in-the-room or remote installation. 3 to 15-ton capacities for industrial or commercial applications. Easily accessible piping and connections simplify installation. Compact water to air unit takes little floor space. Refrigeration cycle removable.



New Climate Changers heat, cool, ventilate . . . solve a wide variety of application problems. Single-zone and multi-zone units that supply different air conditions for as many as 14 zones at the same time. New design features reduce overall costs. 1200 to 47,000 cfm.



This architect's rendering shows the new Day Building on Mt. Olympus, Syracuse University. Economical heating comfort is maintained in this, and two other new Syracuse dormitory multi-zone units controlled by Sarcotherm hot water control systems. Architects: King & King, Syracuse. Engineers: Robson & Woese, Inc. Superintendent of Buildings & Grounds, Syracuse University: E. J. Gibbons. Mechanical Contractors: (on the Day Building, above, and Sadler Hall) Edward Joy Company, Syracuse, N. Y.; (on the women's dormitory) Mechanical Installations Inc., Ozone Park, N. Y.

FOUR-YEAR PERFORMANCE RECORD LEADS TO 15-ZONE INSTALLATION OF SARCOTHERM HEATING CONTROLS

In 1956 Syracuse University installed a Sarcotherm hot water heating control system in an 8-zone dormitory project. Now four years of flawless operation have demonstrated the ability of the Sarcotherm system to deliver complete control of heating comfort – without any maintenance or repair of any kind. As a result, two new Syracuse dormitories have been built with Sarcotherm systems for a total of 15 zones Sarcotherm-regulated.

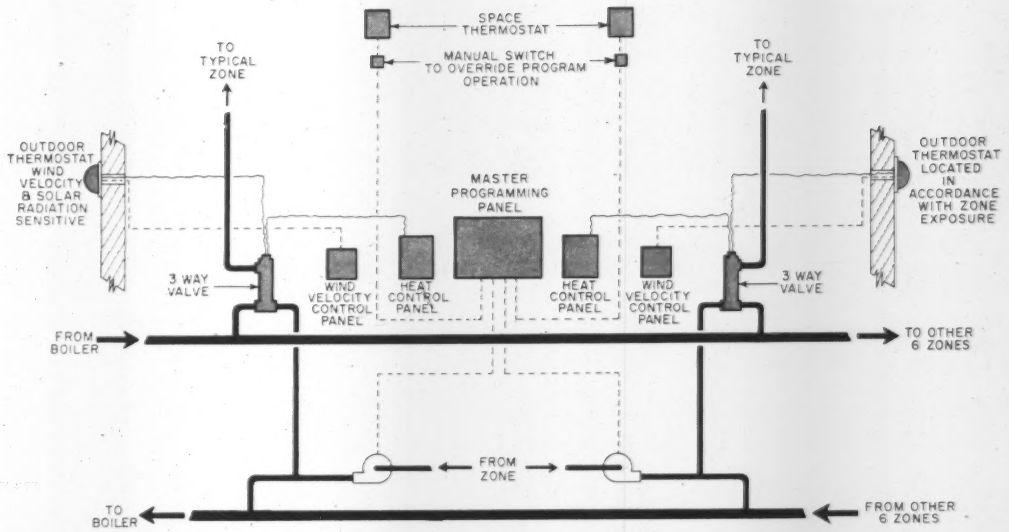
In each zone, Sarcotherm provides precise temperature control, fully allowing for occupancy and exposure, obviating the need for costly individual room control. The Sarcotherm system features a three-way valve controlled by an outdoor thermostat, which is highly responsive to temperature changes, solar radiation and wind load. In addition to this method of anticipating weather before it makes its effect felt indoors, the Sarcotherm system utilizes a master indoor control in each zone, which starts to cool the system as correct temperature is being reached.

This absolutely prevents overheating and prevents wasting fuel. All controls are sealed and are tamper-proof.

SARCOTHERM CONTROLS

Sarcotherm Controls, Inc., an affiliate of Sarco Company, Inc.

635 Madison Avenue, New York 22, N. Y. • Plant: Bethlehem, Pa.



Typical schematic hook-up of the Sarcotherm Heating Control System at Mt. Olympus, Syracuse University. Diagram illustrates only two of the fifteen zones at Mount Olympus.

. . . AND BASIC SIMPLICITY OF RUGGED SARCOTHERM CONTROLS SPEEDED INSTALLATION AND ADJUSTMENT

Fewer parts and uncomplicated wiring greatly simplify Sarcotherm installations. In addition, Sarcotherm unit-packed and tagged every component, prepared complete working drawings, and keyed all parts of these drawings. This substantially reduced installation time. On-the-job cooperation by trained Sarcotherm personnel contributed to the speed and efficiency of the work.

Sarcotherm personnel always make final adjustments and take the system through start-up. Sarcotherm provides complete operating manuals and gives personal instruction to all operating personnel.

In these three modern dormitories, Syracuse University has a control system free of maintenance problems. All of these projects profited from the simplicity of Sarcotherm design and the thoroughness of the installation methods, developed through more than 20 years of specialized experience.

1331

✻ *FOR COMPLETE CONTROL SYSTEM CATALOG* write Sarcotherm Controls, Inc., 635 Madison Ave., New York 22, N. Y.

SARCOTHERM CONTROLS

Sarcotherm Controls, Inc., an affiliate of Sarco Company, Inc.

635 Madison Avenue, New York 22, N. Y. • Plant: Bethlehem, Pa.

For safe, economical school heating...specify an

ECONOMITE LO-BLAST

Gas System

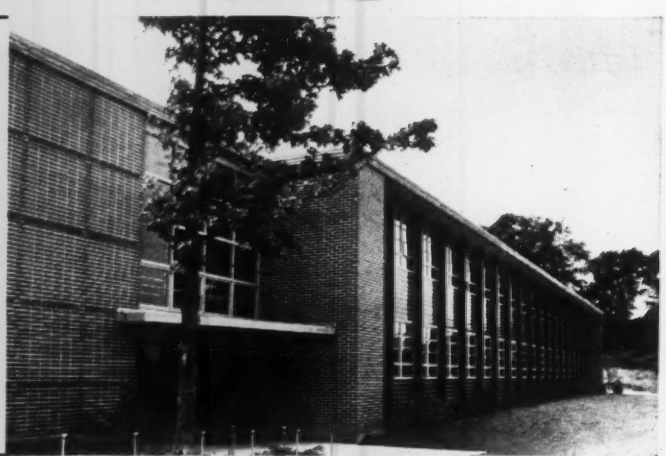
For over 25 years, the Economite Lo-Blast Gas burners have been endorsed by satisfied and enthusiastic users. From a single room to a large school, there's a Lo-Blast Power burner just right for the job.

In addition to providing top dependability, Economite Lo-Blast Gas burners add a bonus of savings in operation. The unit controls primary and secondary air perfectly, functioning independently of variable natural drafts. The unit is especially well-suited for down-draft boilers.

Gas heating can give your schools safe, economical service. For specific information, take advantage of the consulting services provided by your Gas company, as well as Mid-Continent. They have trained heating specialists who have been working with architects, engineers and school boards for years. If you want further information, check with your local Gas company's heating specialist, or write to Mid-Continent Metal Products Co., 1960 N. Clybourn Avenue, Chicago 14, Illinois. *American Gas Association.*

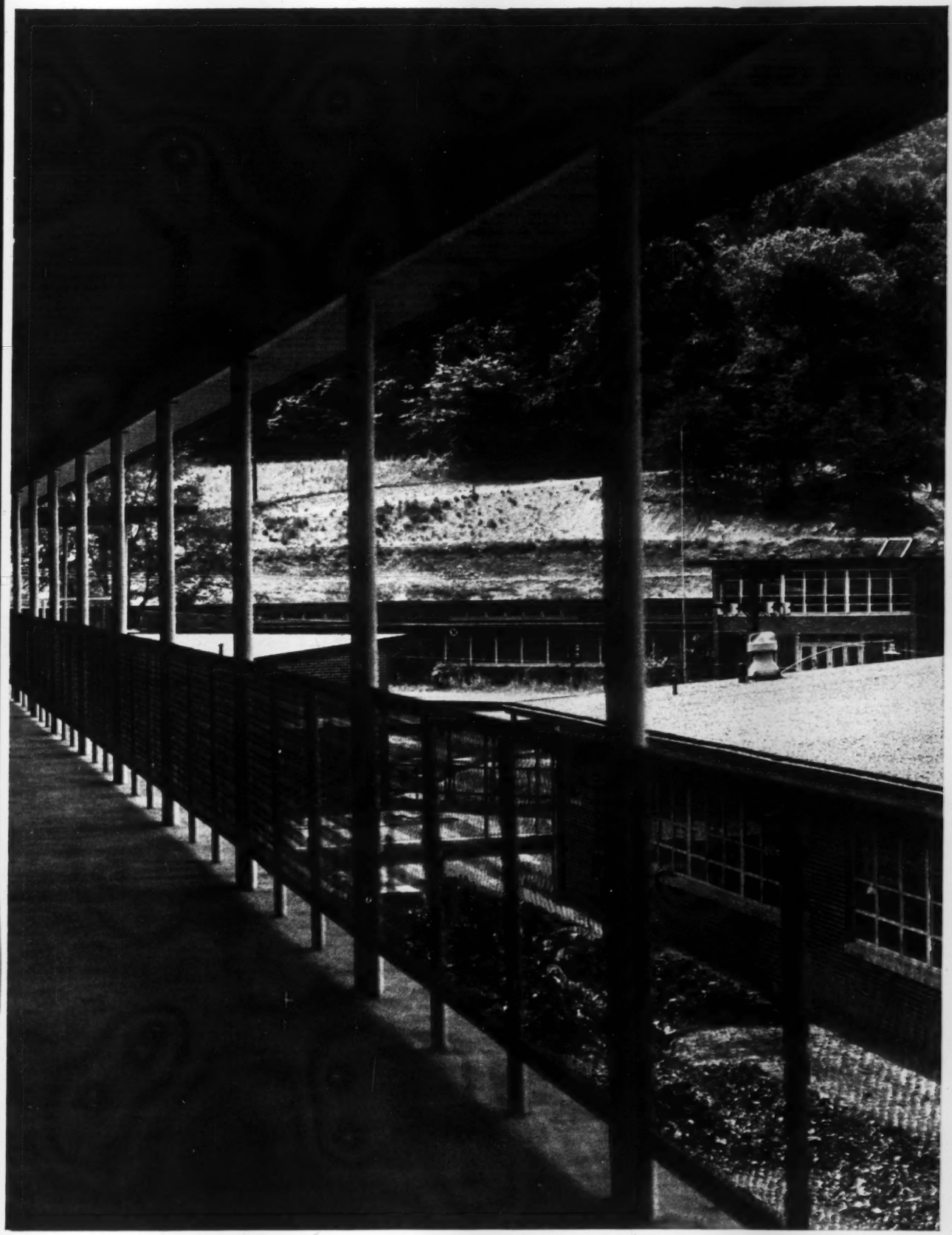
In Birmingham, Alabama, they heat with GAS

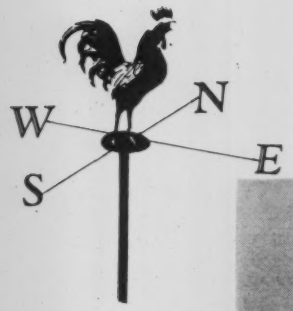
LO-BLAST Power Gas Burners
- *Average 10% lower in operating cost*
- *Cost less to install*
- *Average 10% lower in 70,000 to 20,000,000 BTU input*
- *Silent operation*



Birmingham's Board of Education specified Gas for heating most of its new schools. Experience has proved Gas to be more convenient, cleaner and cuts down on labor costs.

"With the style of architecture we want here in Birmingham, we find that it's more sensible to have small boilers in each building rather than try to build a central plant and pipe the heat to each building," states Mr. Fred J. Kelley, business manager of the City Board of Education. "In many of these new installations, we have specified Lo-Blast Power Gas burners because of their good record here in Birmingham for safe, consistent performance, plus low-cost installation and operation."





LOOK AROUND... YOU SEE

LIBBY-OWENS-FORD
OFFICE BUILDING
Chicago, Ill.

Architect:
Skidmore, Owings & Merrill

Mechanical Engineer:
Guy B. Panero

Project Engineer:
Edward Pita

Contractor:
Stanley Carter

REQUIREMENT: The specification called for a low height cooling tower to be furnished with Corrugated Corrulux (reinforced fiberglass) in lieu of the standard casing of Corrugated Transite.

SOLUTION: PHILLIPS COOLING TOWER custom-engineering easily permitted the substitution and therefore the cooling tower at the home office of Libby-Owens-Ford is encased with Corrulux. The Corrulux is manufactured by Libby-Owens-Ford.

EVERY STEP CUSTOM ENGINEERED

CASINGS
Selection of material to fit Architectural treatment and surrounding conditions.

BASINS
Redwood, stainless steel, galvanized steel, carbon steel up to and including ¼" thickness with any desired coating, reinforced concrete basins supported on steel beams.

DISTRIBUTION SYSTEM
Spray nozzle type or open Weir gravitational type system.

FANS
Multi-blade, adjustable propeller type fan in cast aluminum, stainless steel or Monel. Either direct driven fan in small sizes or indirect right angle worm gear drives.

FILL
Redwood or pressure treated Douglas Fir. Slip-fit, self-supporting for easy removal for interior maintenance.

FRAMEWORK
Hot dipped galvanized structural steel .250" minimum thickness. Redwood or pressure treated Douglas Fir.

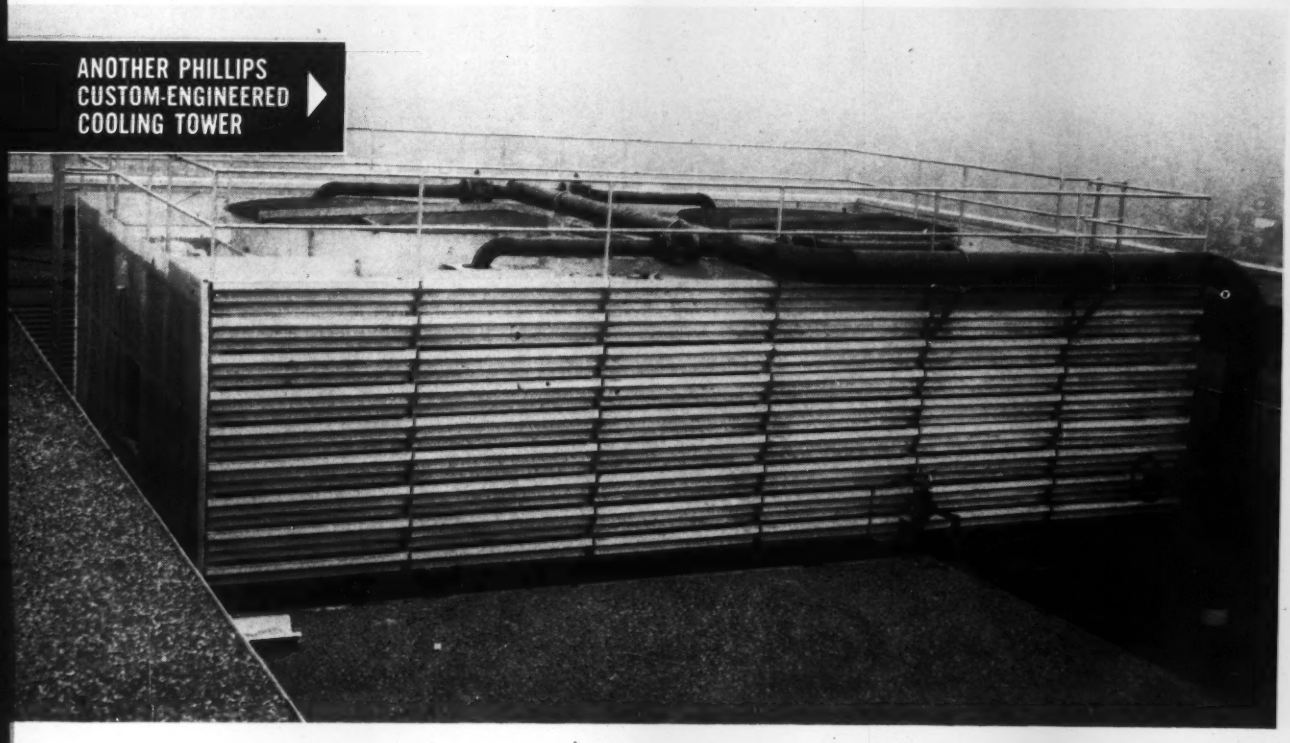
Phillips

CUSTOM-ENGINEERED COOLING TOWERS

EVERYWHERE!

North . . . east . . . south . . . west—coast-to-coast and throughout the world you'll find PHILLIPS CUSTOM-ENGINEERED COOLING TOWERS on outstanding buildings everywhere. And no wonder! For PHILLIPS are the only cooling towers custom-engineered to give you the most efficient . . . most economical solution for your particular problem.

Put PHILLIPS research and development experience to work on your next cooling tower problem. You'll like the results.



Write for literature

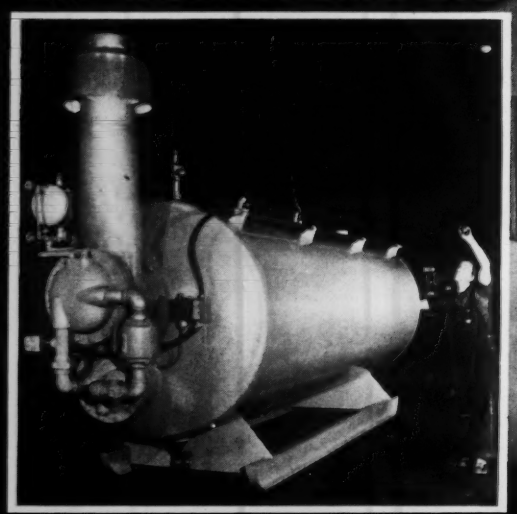
SPECIAL FEATURES ON ALL TOWERS

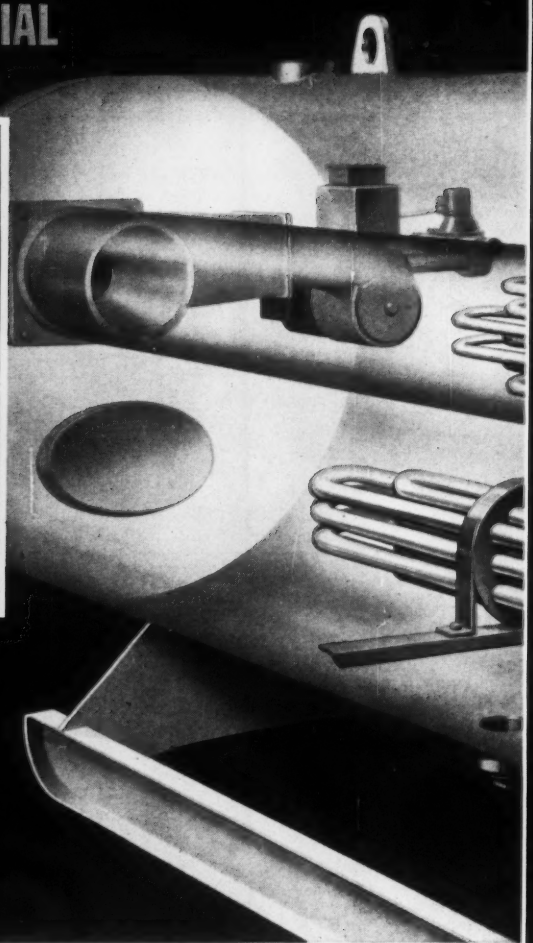
Corrosion Resistant Hardware. Aluminum or Stainless Steel Fans. Nailless Redwood Filling Removable at Tower Base. Nailless Three-Pass Redwood Eliminators. Removable Louvers.

Phillips Cooling Tower Co., Inc.
220 DUPONT ST., BROOKLYN 22, N. Y.

FIRST

INDIRECT GAS FIRED STORAGE WATER HEATER FOR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL USE





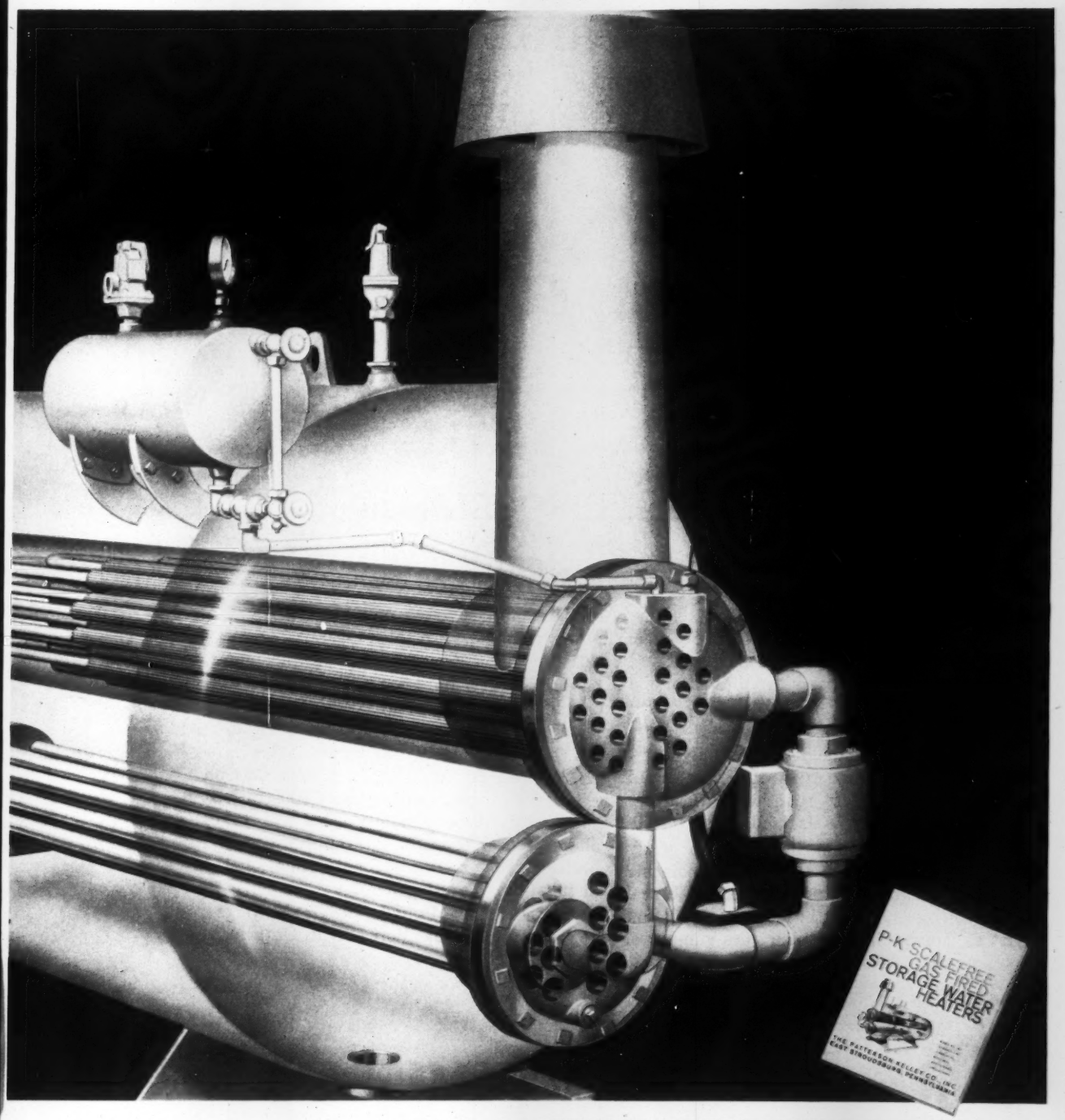
- *No scaling*
- *No drop-off in rated efficiency*
- *No fuel waste*
- *No on-the-job assembly*
- *No complicated maintenance*
- *No limitations on placement*
- *Fully automatic*
- *Copper heating surface*
- *Available in more than 100 storage and recovery combinations*

The first indirect gas fired design in storage water heaters is a rugged industrial type unit with finest controls and safeguards. It is backed by P-K's 80 years of experience in building and designing quality water heating equipment. Its name: SCALEFREE 230*.

P-K SCALEFREE 230 heats surface water through hot intermediate distilled water. Transfer occurs below the temperature at which minerals that cause scaling precipitate. Efficiency remains unimpaired throughout service life. Linings of Pre-Krete or copper are available to keep the unit free of rust and corrosion regardless of water conditions.

SCALEFREE 230 features a new P-K gas burner. It operates at maximum practical efficiency. Yet it gives almost noiseless service—does not rumble or boom on startup. This permits location almost anywhere in office buildings, institutions, schools, motels, etc.

SCALEFREE 230 is a complete fully automatic package that can be quickly set in place, hooked up, and checked out. It requires only simple electrical, water and gas connections. No stack is needed for extra draft—only a vent.



No foundation is necessary. A rugged skid-in type base is supplied. It is easily accessible for inspection. Tube bundles are removable.

SCALEFREE 230 is completely safe. It has a fail-safe chain of built-in protective devices. It is available in more than 100 storage and recovery combinations. Storage capacities range from 250 to 4000 gallons. Recovery sections range from 390,000 to 2,215,000 Btu. Send the coupon for complete information.

*Patent pending

Patterson Kelley

102 Morgan Ave., East Stroudsburg, Pa.

☐ Please send complete technical data on SCALEFREE 230

☐ Please have a P-K Sales Engineer call to discuss design and operational features.

Name _____ Position _____

Company _____

Address _____

City _____ Zone _____ State _____

Now—a new appearance concept for low-budget commercial installations

The "Power-Plant" Look

with Johns-Manville FIBROCEL Insulation!

Now you can bring the traditionally fine appearance and performance excellence of your power plant work to general commercial and industrial installations... with Johns-Manville Fibrocel® Insulation!

Why these power plant advantages? Simply because Fibrocel is molded! The only commercial insulation made (by a precision metal mold) to near-perfect roundness, with unmatched uniformity of size and line.

This means an immediate end to costly finishing, heavy jacketing, needless pointing up of cracks and apertures. Instead, Fibrocel gives you a tighter, better looking installation just as it is applied. Pipelines are gun-barrel straight, firm end to end. The look of a power plant!

Fibrocel's dimensional uniformity again pays off in fuel savings—pipe is always "dead center," with lengths butted tight to provide maximum insulating effectiveness.

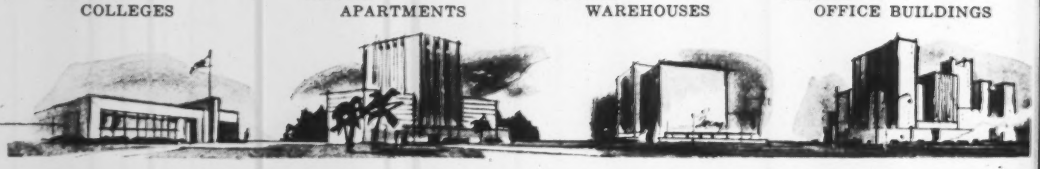
Let us send you the informative new brochure, IN-155A. It gives you full details on Fibrocel's thermal performance. Illustrations show why Fibrocel installs easier . . . takes abuse, too. Keeps its fine appearance and performance excellence for the life of the installation. Write for it today!

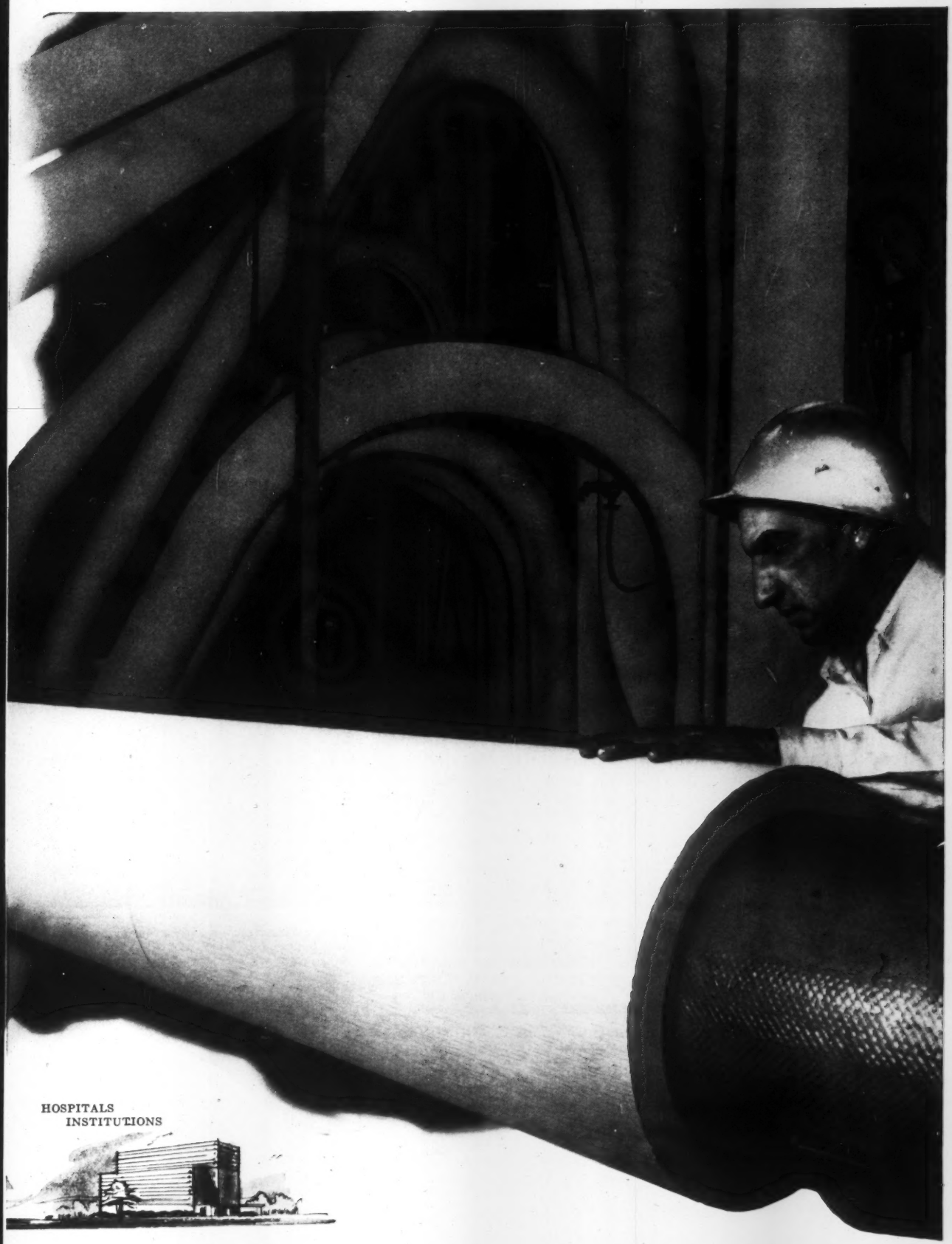
Address Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE

...Specify Fibrocel for the "POWER PLANT" look in installations like these (35F to 300F)




HOSPITALS
INSTITUTIONS

Modern use of coal cuts fuel costs 22%

In addition, coal costs Uniontown Hospital $3.00 per ton less than gas!

Expansion of facilities at Uniontown Hospital, Uniontown, Pa., increased the demand for steam used for space heating, water heating, kitchen, laundry and sterilizing equipment. An engineering survey was conducted which indicated the need for a new plant rather than modernization of the old one. Hospital officials —working with Altman and Altman, Architects, and Paul S. Park, Consulting Engineer—decided to install a completely automatic steam plant. Coal continues to be used because it meets the hospital's rigid standards for cleanliness and has proved the most economical fuel. Not only has burning coal this modern way shown a 22% savings in fuel costs compared to the old plant but, per equivalent ton, coal actually costs $3.00 less than its nearest competitive fuel!

COAL IS LOWEST COST FUEL

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% more steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

CONSULT AN ENGINEERING FIRM

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

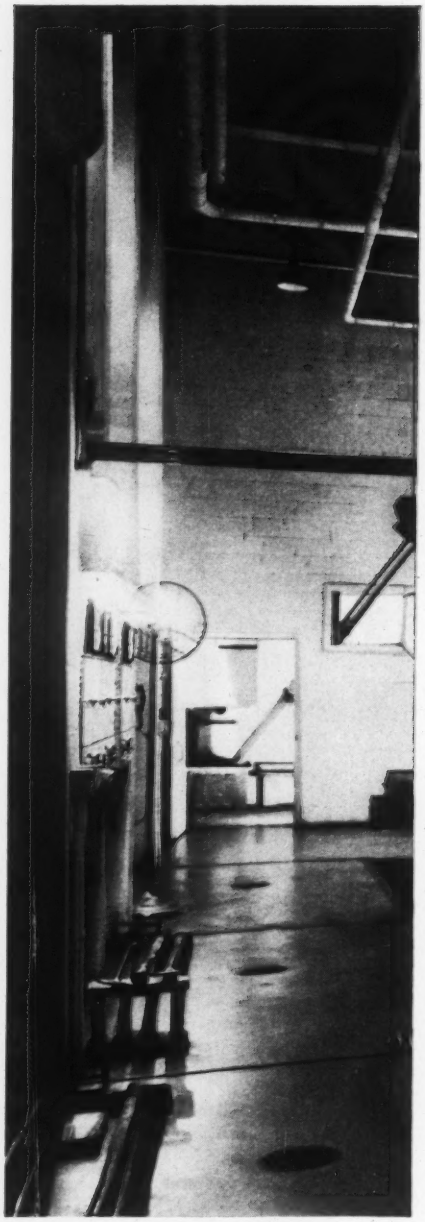
TECHNICAL ADVISORY SERVICE

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

BITUMINOUS COAL INSTITUTE

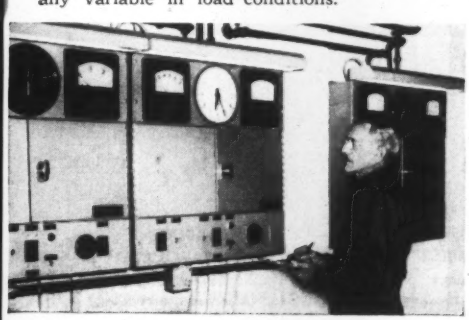
Department HP-03, Southern Building, Washington 5, D.C.

See our listing in Sweet's Files: A-30J/Bi; PE-4a/Bi; IC-18b/Bi

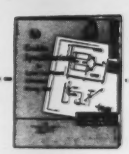


Coal is discharged into bin and gravity fed into hopper box, then moved by inclined screw conveyor into horizontal screw conveyor leading to stoker hoppers and boilers. Boilers are Keeler 10,000 lb/hr "CP" type units, 150 psi. Coal handling system by Auburn Foundry Company.

The completely enclosed electric-type combustion control panel (Cleveland Controls, Inc.) contains assembly units for all power control and coal handling operations. Steam flow meters, strategically located throughout the hospital, enable the operating personnel to determine any variable in load conditions.



SEND COUPON FOR NEW BCI PUBLICATIONS
Guide Specifications, with complete equipment criteria and boiler room plans:



Bituminous Coal Institute HP-03
Southern Building, Washington 5, D. C.

Gentlemen: Please send me:

☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker).
☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker).
☐ GS-3 (automatic package boiler for heating and process plants).
☐ Case histories on larger plants.

Name _____

Title _____

Company _____

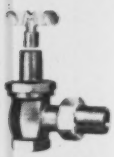
Address _____

City _____ Zone _____ State _____

MARSH PACKLESS RADIATOR VALVES

WHEEL HANDLE

GRADUATED



LOCK AND SHIELD

ANGLE PATTERN

GLOBE PATTERN

CORNER PATTERN (Sectional Below)

MARSH THERMOSTATIC RADIATOR TRAPS

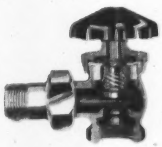
ANGLE PATTERN

STRAIGHTWAY PATTERN

VERTICAL PATTERN

LEFT HAND CORNER PATTERN

RIGHT HAND CORNER PATTERN



CUT OPEN VALVE

F&T TRAPS

No. 12, REPRESENTATIVE OF WIDE LINE

VENTS

No. 5 VENT, ONE OF MANY

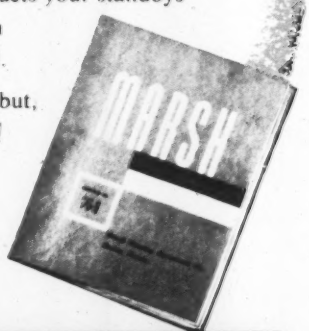
BUCKET TRAPS

No. 500 INVERTED BUCKET TRAP

All the best of their kind!

You probably have made certain Marsh products your standbys without realizing there are a lot more of them just as superlative as the ones you like so well.

Make the acquaintance of some of them here, but, better still—***Ask for this Marsh Catalog!***



MARSH HEATING EQUIPMENT COMPANY
Division of Colorado Oil and Gas Corporation
DEPT. T, SKOKIE, ILL.
Marsh Instrument & Valve Co. (Canada) Ltd.
8407 103rd St., Edmonton, Alberta

MARSH
Heating Specialties since 1865

GAUGES AND THERMOMETERS

THER-ALTI-METER (Square and Round)

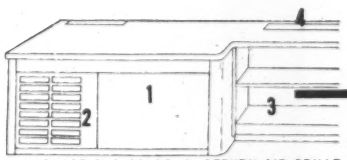
HOT WATER BOILER THERMOMETER

PIPING THERMOMETER
Four Ranges
(Also remote reading)

DUCT THERMOMETER
Three Ranges
(Also remote reading)

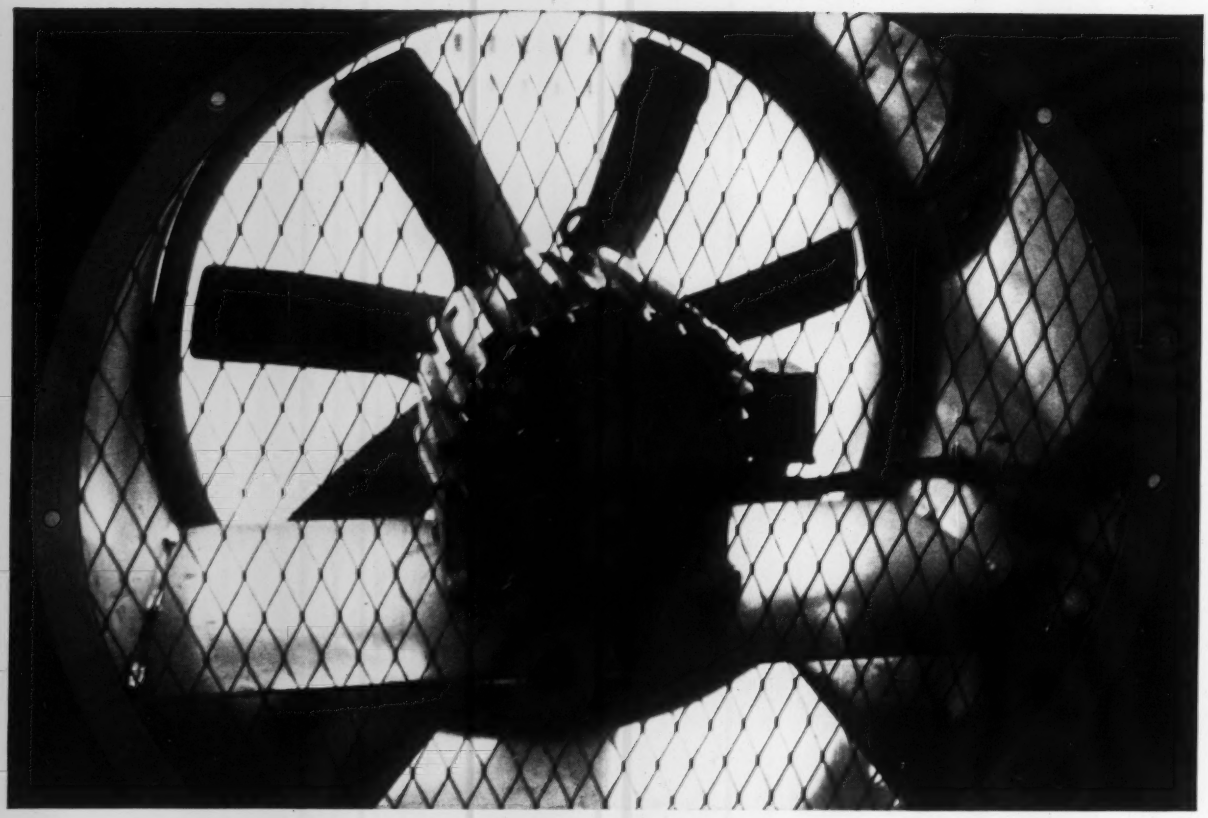
Gas-fired **Norman Schoolroom Heating and Ventilating Systems** are installed quickly at low cost . . . and there's plenty of latitude for future economy in school expansion! Each Norman forced warm-air system supplies heat rapidly when it is needed . . . blends fresh outdoor air and recirculated room air to cool and ventilate the schoolroom . . . and distributes tempered air evenly along and out from the exposed walls. Expensive boiler rooms, stacks, pipe tunnels, boilers and control panels are eliminated right from the start. As the school grows, additional Norman Systems can be added.

Write Today for New 1960 Comprehensive Manual
See folder in 1960 Sweets Arch. File 31h/No

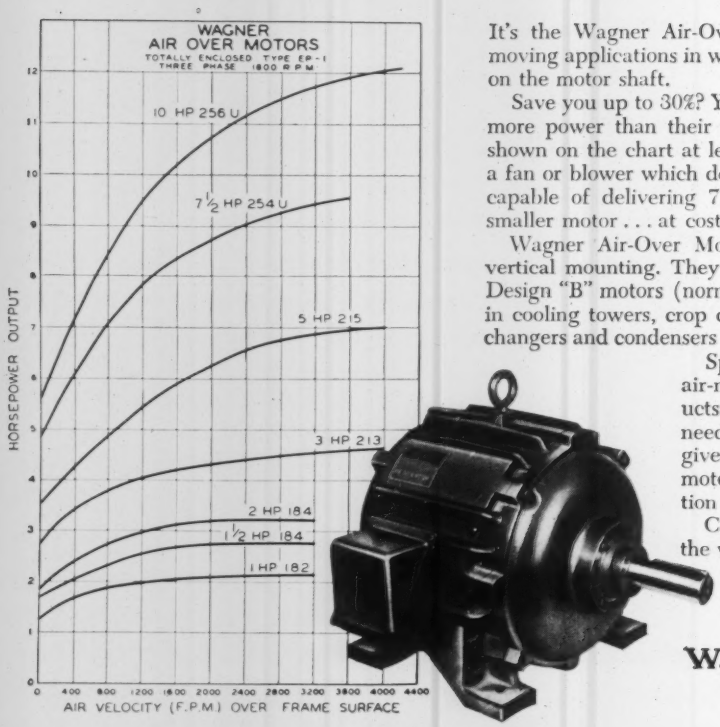


1. FURNACE ENCLOSURE 2. RETURN AIR GRILLE
3. UTIL-I-DUCT® BOOKSHELF 4. AIR DIFFUSER

Norman®
PRODUCTS CO. • 1156 Chesapeake Ave. Columbus 12, Ohio



This Wagner Motor can save you up to 30% in costs on air-moving equipment


WAGNER
AIR OVER MOTORS
TOTALLY ENCLOSED TYPE EP-1
THREE PHASE 1800 R.P.M.
10 HP 256 U
7½ HP 254 U
5 HP 215
3 HP 213
2 HP 184
1½ HP 184
1 HP 182
HORSEPOWER OUTPUT
0 1 2 3 4 5 6 7 8 9 10 11 12
0 400 800 1200 1600 2000 2400 2800 3200 3600 4000 4400
AIR VELOCITY (F.P.M.) OVER FRAME SURFACE

It's the Wagner Air-Over Motor . . . *specifically* designed for air-moving applications in which a propeller or axial flow fan is mounted on the motor shaft.

Save you up to 30%? Yes, for Wagner Air-Over Motors can deliver more power than their rated horsepower output. For example, as shown on the chart at left, a 5 horsepower rated motor installed in a fan or blower which delivers about 4,000 feet of air per minute is capable of delivering 7 horsepower. You get more work from a smaller motor . . . at costs up to 30% less.

Wagner Air-Over Motors are suitable for either horizontal or vertical mounting. They are totally-enclosed, nonventilated NEMA Design "B" motors (normal torque—normal slip). You can use them in cooling towers, crop dryers, exhaust systems, air-cooled heat exchangers and condensers . . . any air-over fan and blower application.

Specify Wagner Air-Over Motors for all your air-moving equipment applications. Your products will operate at peak efficiency for years, need less service and fewer repairs. And, you'll give your customers equipment powered by motors they know . . . motors that have a reputation for long, dependable service.

Call your Wagner Sales Engineer now . . . get the whole Wagner Air-Over Motor story. There are Wagner Branches in 32 principal cities across the country.

Wagner Electric Corporation
6370 Plymouth Ave., St. Louis 33, Mo.

WM60-13

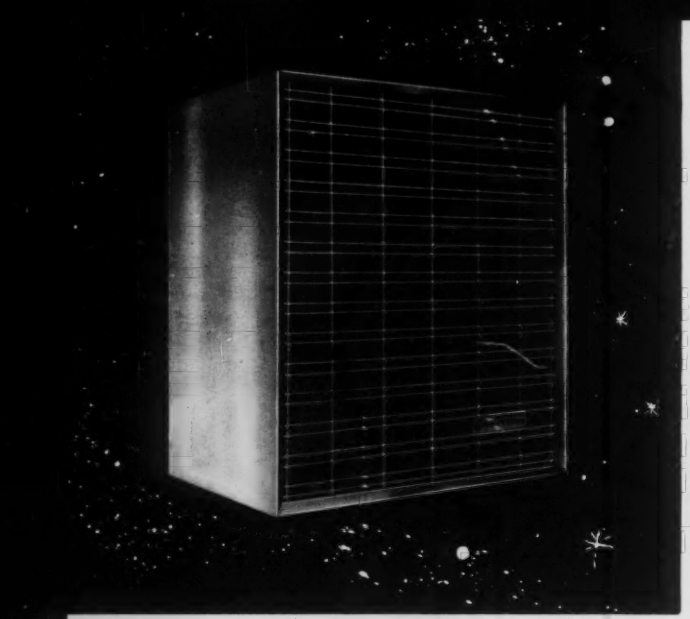
JANITROL

presents a dramatically new achievement...

67 SERIES

GAS-FIRED UNIT HEATERS

UNPRECEDENTED STYLING, PERFORMANCE AND DURABILITY TO MEET THE MODERN TREND IN ARCHITECTURAL DESIGN



provide the ultimate in quality and economy

new JANITROL GAS-FIRED

commercial & industrial heating equipment

ALL NEW! JANITROL 67 SERIES UNIT HEATERS FEATURING. . . STELLAR NEW STYLING, PERFORMANCE AND DURABILITY!

New Janitrol 67 Series Unit Heaters are unusually handsome . . . incredibly quiet and efficient. They bring you, for the first time in unit heater history, distinctive appearance you can recommend for the smartest business setting. And they offer in even greater measure the traditional Janitrol quality and dependability in heating.

Their clean, crisp "look" is a departure from the crude, cumbersome industrial appearance of yesterday. Modern machine tools, trucks and structures have evolved as attractive, functional designs. And now, Janitrol sets the pace in unit heater styling!

The draft hood opening and adjustable louvers are concealed by the beautifully styled gold-tone grille. The rear combustion air inlet permits use of a solid bottom panel . . . eliminates any possibility of obstruction to combustion air intake.

Inside, design progress is equally significant. Yet every part is proven . . . every safety feature is included. Result? Performance no other unit heater can duplicate.

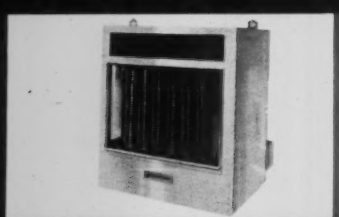
Naturally, the "heating heart" of every new Janitrol is the famous Janitrol Multi-Thermex heat exchanger with this unchallenged record for durability and low maintenance: among nearly three million heat exchanger tubes produced since 1940, replacements for all causes have run less than ¼ of 1%.

Investigate the many exclusive advantages of Janitrol 67 Series Unit Heaters for jobs you specify or install. Let them help build your reputation for quality.

FEATURES THAT MAKE ALL OTHER UNIT HEATERS OLD-FASHIONED!

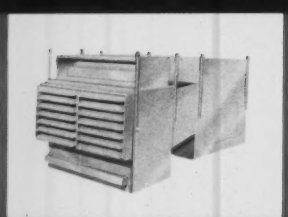
New "sheer look" styling—Beautiful Phoenix Beige finish • New gold-tone grille. Conceals louvers and draft hood opening • Low overall height • Automatic controls—Fully accessible • Factory-fired • Low Voltage Gas Controls—Standard • Low Voltage Sensitive Thermostat—Standard • Limit control—interrupts control circuits and shuts off fuel if unit temperature becomes excessive • Thermopilot Shut-off. Shuts off all gas, including pilot, in event of pilot flame failure • Automatic Pilot. Exclusive Janitrol low Btu. non-linting design • Quiet air delivery. Acceptable for schools and other applications where conventional units are too noisy • Motor prelubricated for 5 years • Built-in Draft Hood. Removable, provides full access to heat exchanger. Protects burners from abnormal up or down draft • Combustion air inlet. At bottom rear, through control enclosure. Controls constantly cooled by combustion air stream. Eliminates cross draft on burners • Ampli-Fire Ribbon Flame Burners. No flame contact on metal. Removable, with non-linting air shutters featuring thumb-screw adjustment.

MEET EVERY COMMERCIAL AND INDUSTRIAL HEATING NEED FROM JANITROL'S BROAD LINE



GAS-FIRED DUCT-FURNACES

Install in a duct where air is circulated by separate blower. Adaptable for use with cooling. Two sizes: 200,000 and 300,000 Btu/hr. input—may be combined to provide capacity from 200,000 Btu/hr. up, in increments of 100,000 Btu/hr. input. Six sizes, from 50,000 to 225,000 Btu/hr. in Duct 55 models.

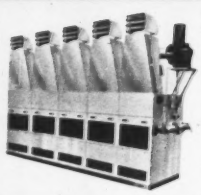


BLOWER-TYPE UNIT HEATER

Allows air delivery from greater heights and against greater static pressures. Models with exposed or enclosed blowers. A.G.A. approved as low and high static-type blower unit heater for air delivery to duct system up to 1.0 in. W.C. external static. Heat sections factory assembled. Sizes: 300,000, 400,000 and 500,000 Btu/hr. input.

FLOOR-TYPE UNIT HEATER

Cold air drawn from floor level is heated, filtered and discharged horizontally overhead. Quiet, clean, carefree—ideal for offices, restaurants, stores, labs, etc., requiring a compact unit.



HEAVY DUTY BLOWER HEATERS

For unit heating, central heating and air conditioning. Wide range of standard blowers and motors assures correct air delivery and temperature rise in each application. Factory assembled and tested. Capacities from 250,000 Btu to 1,750,000 Btu/hr. input.

HORIZONTAL OIL UNIT HEATER

For suspension overhead. Saves floor space. Compact, efficient, low-maintenance design clean and quiet in operation. May also be used to feed duct system. Choice of sizes from 84,000 to 250,000 Btu/hr. output to meet all needs.

helpful data for **ARCHITECTS, CONTRACTORS AND ENGINEERS**

write collect today for complete information on Janitrol units for heating with clean, economical gas in buildings of every type. There's no obligation.

JANITROL

HEATING AND AIR CONDITIONING

A Division of Midland-Ross Corporation

Columbus 16, Ohio • In Canada: Moffats Ltd., Toronto 15

Also Makers of Surface Industrial Furnaces, Kathabar Humidity Conditioning, Janitrol Residential Heating and Cooling Equipment.

SPECIFY COPPER TUBE AND PIPE MADE THE QUALITY WAY . . .

MADE IN U.S.A.

BECAUSE:

- You are assured of *consistent* quality time after time.
- You support your fellow American workers.
- You help build your reputation and America's prosperity.
- You can count on a reliable source of supply.

TYPES K, L, M, DWV, COPPER AND BRASS PIPE

The All-American Line From Mine to Market

PHELPS DODGE COPPER WATER TUBE

- Highest grade copper from Phelps Dodge's own mines.
- Controlled quality assures unsurpassed tube properties, including precise uniformity of wall thickness.
- Color-coding of straight-length tubes for instant identification.
- Packaging that's easy to stock, easy to use.
- Mill depots strategically located for speedy service.

Quality tube sold the Quality way—through wholesalers

PHELPS DODGE COPPER PRODUCTS CORPORATION

NEW YORK, N. Y. • LOS ANGELES, CALIF.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

NEW...FROM TUBE

FROM YOUR TUBE TURNS' DISTRIBUTOR

The complete line of PIPE-MATE Fittings, Flanges and Accessories are available from your nearby Tube Turns' Distributor. For pipe sizes ½" to 4"... Schedules 5S and 10S... in Types 304L, 316 and 316L.

TURNS...

PIPE-MATE light-wall stainless steel fittings and flanges

Tube Turns introduces another important key to lower piping costs... a new line of light-wall stainless steel fittings and flanges for process piping. Here's how this PIPE-MATE* line reduces costs...

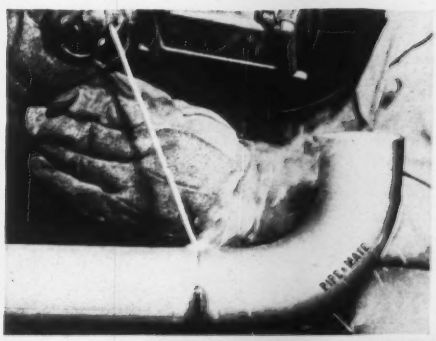
Cuts material costs. Compared to standard weight Schedule 40S pipe, *light-wall* piping in Schedule 5S or 10S cuts material costs as much as 30% to 50%. It weighs ½ to ⅓ as much, is easier to handle, easier to install and provides greater flow area.

Simplifies installation. Extra long tangents of PIPE-MATE fittings provide full straight-line clearance for fitting-to-fitting connections and permit fabrication of completely flanged elbows, returns, tees, etc. Aligning connector speeds making of socket type joints. Fittings may be butt-welded, fillet-welded, brazed or soldered, or joined by rolled-in flange connections.

Here is another plus value you get when you specify products of Tube Turns and buy them from your Tube Turns' Distributor.

FREE BULLETIN on PIPE-MATE Fittings and Flanges describes complete line, shows installation procedures, and gives properties and dimensional tolerances. Mail coupon for copy.

*"PIPE-MATE" and "tt" are trademarks of Tube Turns.



FOR BUTT-WELDING

FOR FILLET-WELDING, BRAZING OR SOLDERING

FOR ROLLED-IN FLANGED JOINTS

Another tt *plus value from...*

TUBE TURNS

DIVISION OF CHEMETRON CORPORATION

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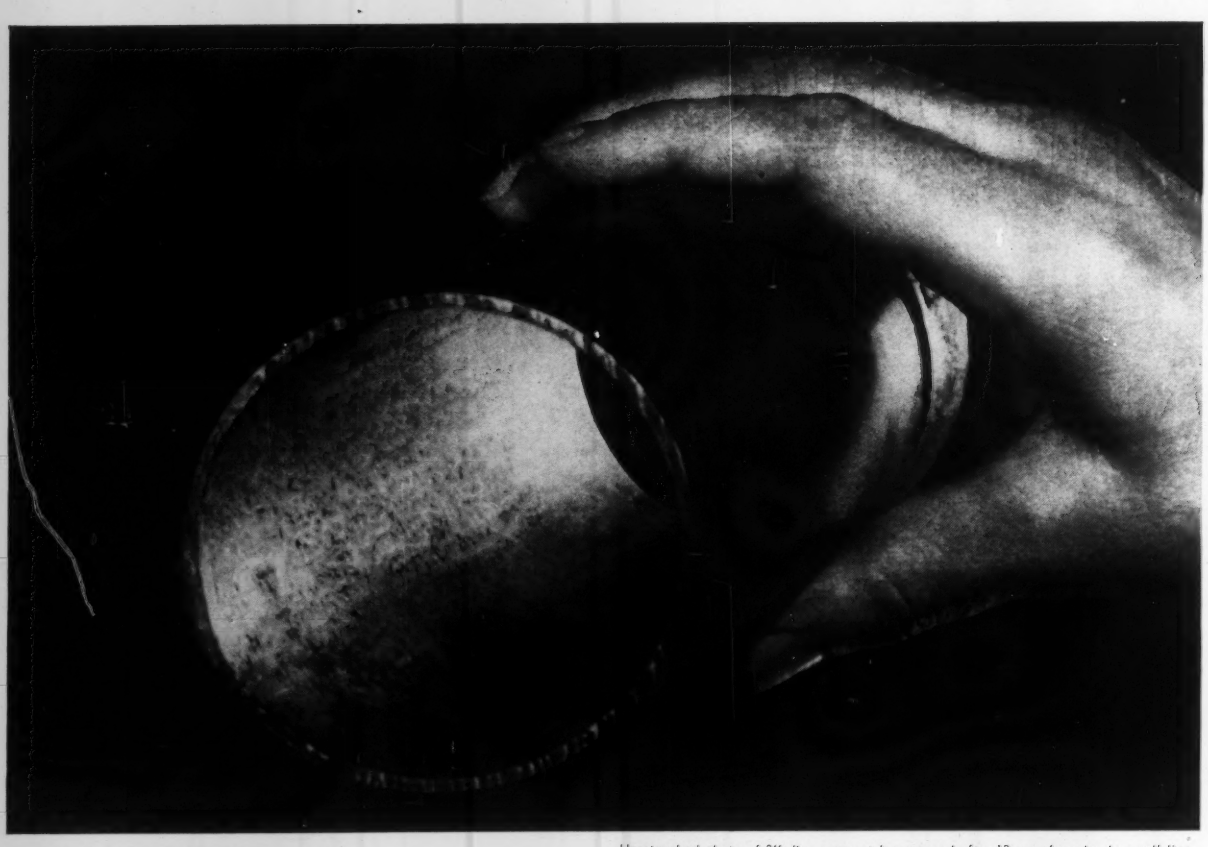
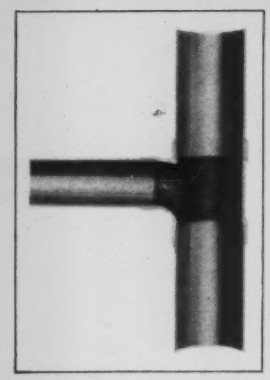


Unretouched photo of 3" dia. copper tube removed after 13 years' service in a soil line.



Anaconda drainage fittings are designed to match Anaconda tube for fast, easy solder connections.

WASTES FLOW FREELY IN COPPER DRAINAGE SYSTEMS AND YOU SAVE MONEY. Compare the condition on the inside of this copper tube with what you might expect to find in ordinary piping after 13 years in service. Rust-caused troubles such as reduced flow or stoppages do not occur inside copper drainage lines. That is why many plumbing codes allow the use of 3" diameter copper tube for soil line and vent. Material costs are reduced and, because a 3" copper tube stack with fittings fits inside a standard 4" partition, the need for expensive, space-consuming plumbing walls is eliminated. Save time, effort, and money—install the modern drainage system with Anaconda copper tube and fittings. For information, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

6901

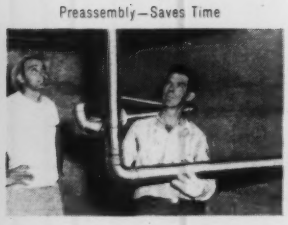
ANACONDA®

COPPER TUBE AND FITTINGS for soil, waste and vent lines

Available through plumbing wholesalers. Products of The American Brass Company

Longer Lengths—Fewer Joints

Preassembly—Saves Time



Lightweight Copper—Easier Installation

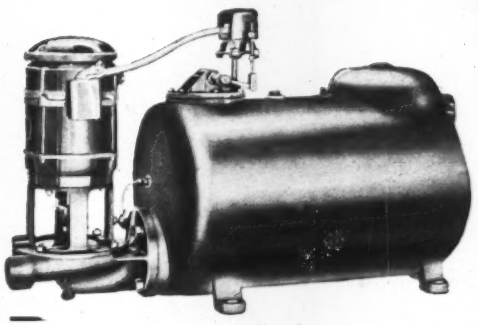
Compact Connections—Save Space

NO NEED FOR CUSTOM JOB

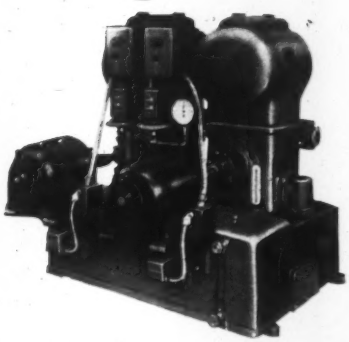
A standard type Skidmore Pump will meet the exacting requirements

TYPE "VC" PUMP

Furnished in single or duplex units. Bulletin 10-B

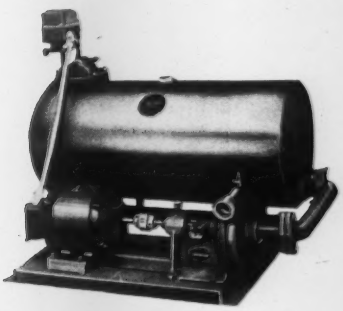


4 ways . . . to improved pump performance!



VACUUM PUMP

Furnished in single or duplex units. Maintained efficiency. Bulletin 9-B



TYPE HS PUMP

Furnished in single or duplex units. Bulletin 14-B

TYPE CCVS PUMP

Three new single units, two duplex. Bulletin 21-C

Let Skidmore assist you in your heating pump plans. Write for bulletins.

SKIDMORE CORPORATION

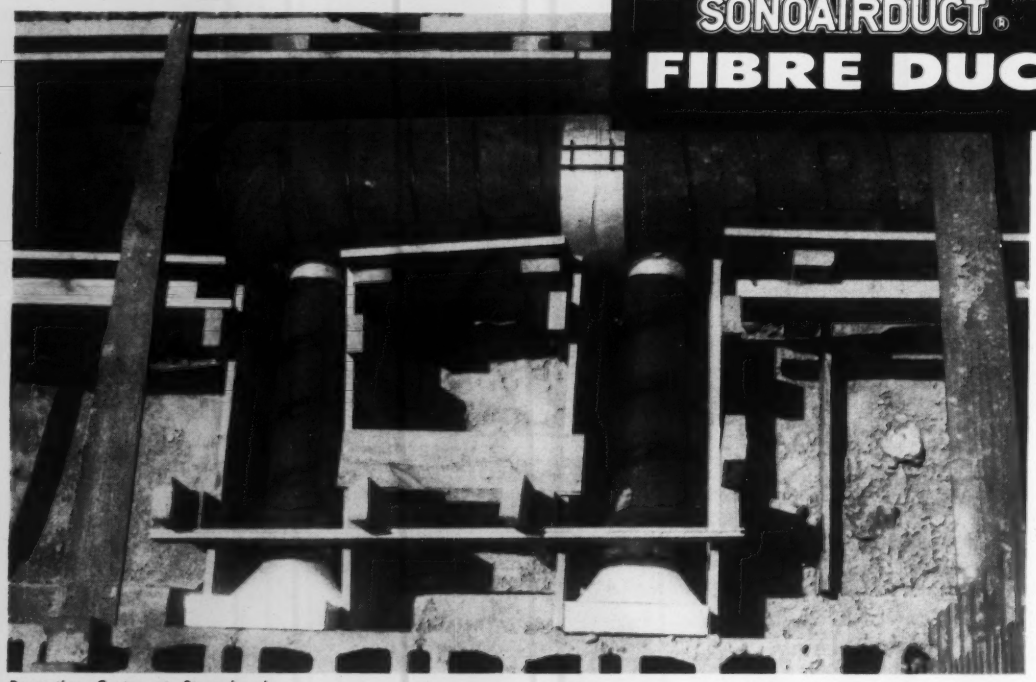
ST. JOSEPH, MICH.

Choose with Confidence!

COMPARE

slab perimeter duct for cost, for
handling ease, for speed of installation

...and you'll choose SONOCO SONOAIRDUCT® FIBRE DUCT

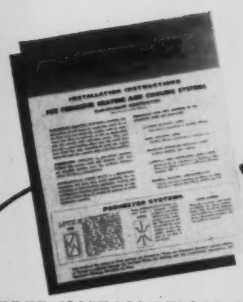


Recreation Center at Stoneybrooke Estates, Warwick, Va. Architect: Williams-Coyl-Blanchard. General Contractor: Stoneybrooke Estates, Inc. Heating Contractor: Ralph Huskey

Especially designed for use in slab perimeter heating or combination heating-cooling systems, SONOAIRDUCT Fibre Duct costs less, handles easier, levels quicker . . . saves time, labor, and money.

Contractors like the long lengths, the absence of sharp cutting edges, the speed of joining and leveling. And, SONOAIRDUCT Fibre Duct won't chip, crack, or break when dropped—every piece is usable. Aluminum foil-lined Sonoco SONOAIRDUCT, the original Fibre Duct, is America's *best seller*—proof of dependable performance.

Available in 23 sizes, 2" to 36" I.D., in 18' shipping lengths . . . special sizes to order. Easily cut to exact length with hand saw. SONOAIRDUCT Fibre Duct meets or exceeds F.H.A. criteria and test requirements for products in this category.



FREE INSTALLATION MANUAL
Contains latest, detailed, step-by-step installation data for SONOAIRDUCT Fibre Duct. For free copy, send us your name and address on company letterhead.

See our catalog in Sweet's, or write for complete information and prices to

- HARTSVILLE, S.C.
- LA PUENTE, CALIF.
- FREMONT, CALIF.
- MONTCLAIR, N.J.
- AKRON, INDIANA
- LONGVIEW, TEXAS
- ATLANTA, GA.
- BRANTFORD, ONT.
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Construction Products

SONOCO PRODUCTS COMPANY 4491

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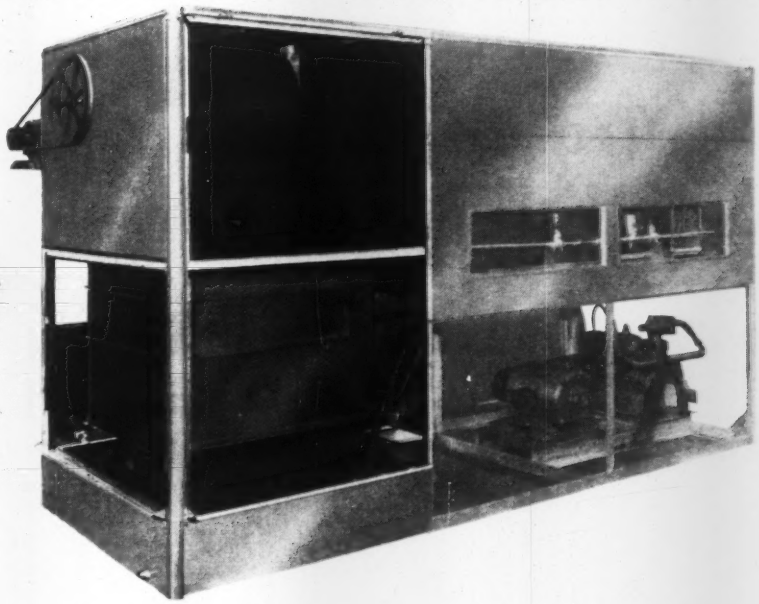
IN QUALITY
AND PERFORMANCE

SPECIFY PROLONGED LIFE!



Governair's

COPPER FITTED

EVAPORATIVE CONDENSER

FEATURES:

ALL COPPER AND BRASS water pan, float valve, condenser coil, spray tree, eliminators, blower scrolls. Standard galvanized blower wheels and stainless steel shaft.

WRITE FOR COMPLETE INFORMATION

You have a definite feeling of confidence when you specify Governair's COOPER-FITTED evaporative condenser with its many fine features.

ALL spray water is contained within a COPPER WATER JACKET. This exclusive DOUBLE WALL CONSTRUCTION assures product longevity and lower maintenance. In fact, throughout the entire unit, you find QUALITY . . . with no worry about faulty galvanizing or temporary corrosion protection.

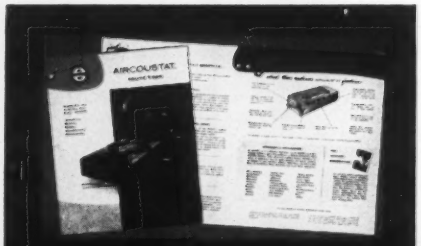
You also have an extremely WIDE SELECTION, as this evaporative condenser is supplied for REMOTE installation or as an integral part of Governair Corporation's self-contained PACKAGED equipment . . . Conventional; Multi-Zone (as pictured); and Water Chillers.

GOVERNAIR

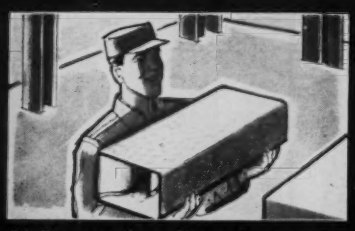
4840 N. SEWELL • OKLAHOMA CITY

7 ways AIRCOUSTAT®
can save you time and money

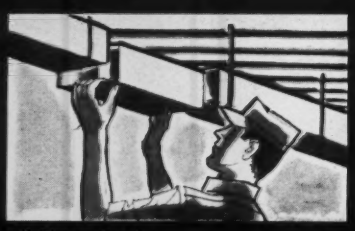
Sound Traps . . . with Guaranteed Results



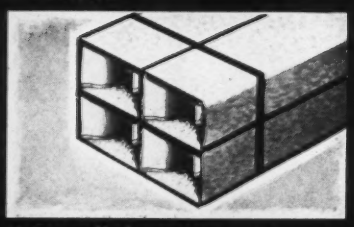
1) Easy to select—Just 3 steps to specify proper model. Save time, avoid errors.



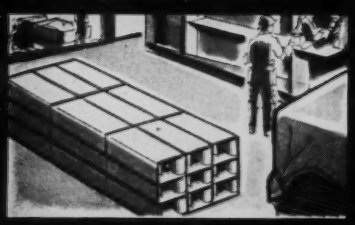
2) Easy to handle—No riggers or special equipment needed. Large units composed at job site.



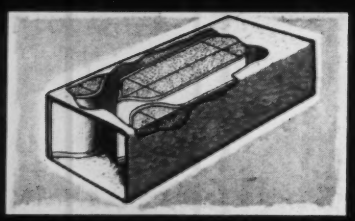
3) Easy to install—Units are installed the same as ductwork. Units have 2" extensions.



4) Fits all duct sizes—Big units are easily assembled from small Aircoustat units.



5) No storage problem—Units are delivered right to the job site, ready to install.



6) No maintenance—Units are fire-resistant, dust-proof and built to last a lifetime.

7) Guaranteed results—Solves every noise reduction problem. Units are completely reliable.

Pre-engineered by Koppers to eliminate guesswork, unnecessary calculations and difficult installations, AIRCOUSTAT Sound Traps guarantee trouble-free silencing of all duct-transmitted noise . . . at a savings in time and money to you.

AIRCOUSTAT selection is quick, simple and reliable. A choice of over 60 stock models, fabricated in 6 lengths, solves every noise reduction problem. AIRCOUSTAT is built to give a lifetime of maintenance-free service.

Write today for your copy of the AIRCOUSTAT Selection Manual, a quick guide to the right unit or combination of AIRCOUSTAT units to eliminate duct-transmitted noise in all air handling systems. Write KOPPERS COMPANY, INC., Sound Control Department, 3303 Scott Street, Baltimore 3, Maryland.

KOPPERS

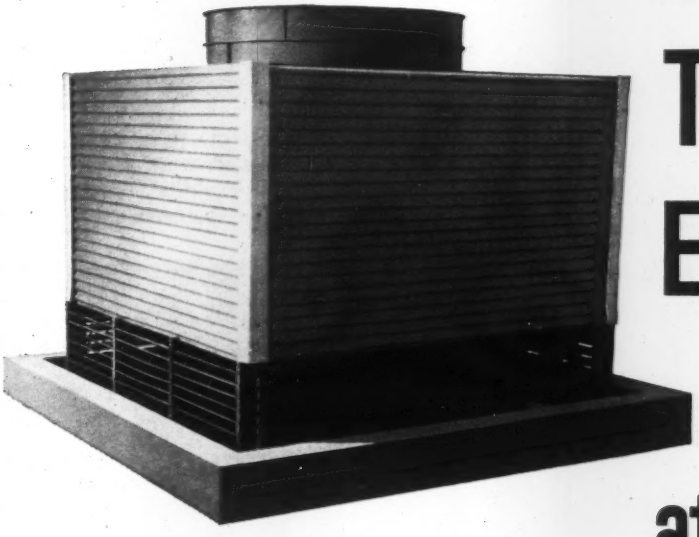
SOUND CONTROL

METAL PRODUCTS DIVISION

Engineered **Products Sold with** ***Service***

FLUOR OVER 40 YEARS OF COOLING TOWER EXPERIENCE at your service *

* Since 1919 Fluor has been building cooling towers throughout the world. (An average of one new industrial or commercial cooling tower is erected by Fluor every three days.)



Ask for our brochure that shows why Fluor Towers mean more efficient operation.

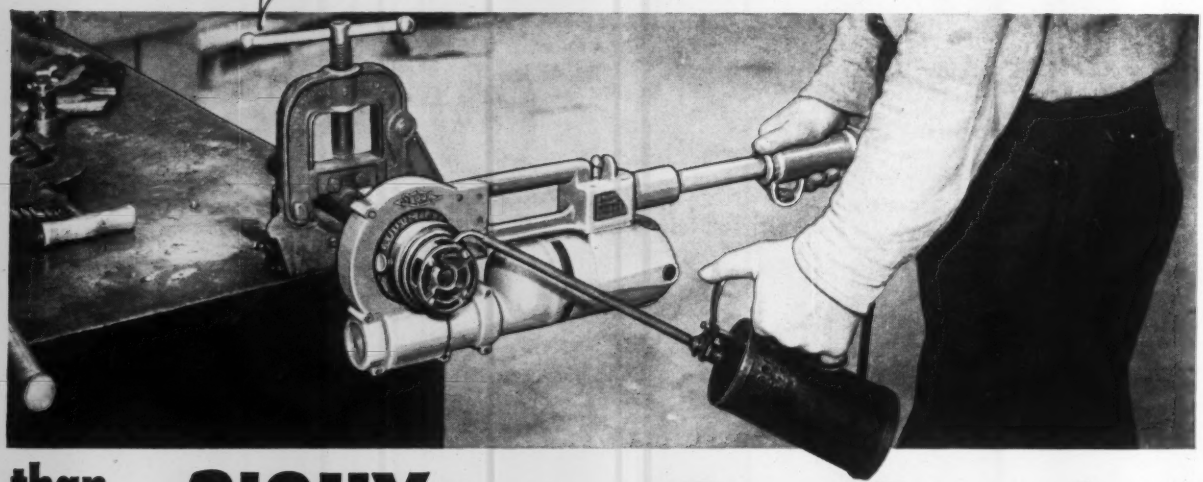
Fluor PRODUCTS COMPANY

AIR CONDITIONING
AND REFRIGERATION
COOLING TOWERS

A division of The FLUOR CORPORATION, Ltd.

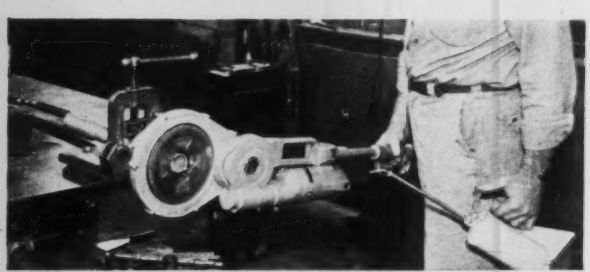
GENERAL OFFICES:
SANTA ROSA, CALIFORNIA

"Nothing Ever Saved More Time....."

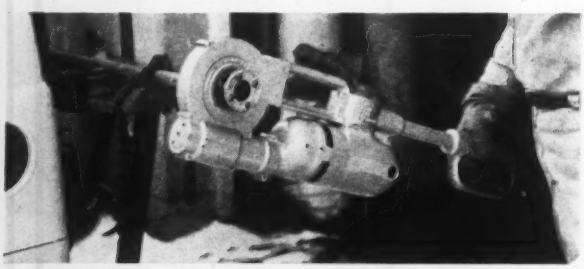


than the new SIOUX Power Pipe Threader!

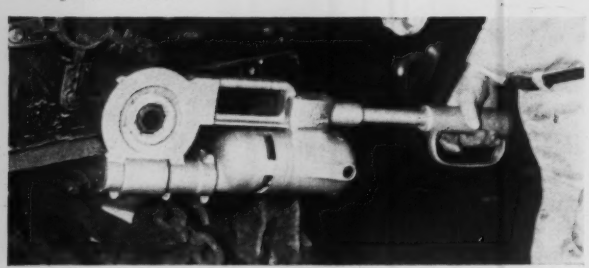
WITH THE SIOUX POWER PIPE THREADER you can thread ¼" to 1" pipe in 20 seconds; 1" and 2" pipe in one minute, 24 seconds! When labor costs 6½ cents per man per minute, a power tool like this for which there is a continuing need doesn't take long to pay for itself. The SIOUX Power Pipe Threader is said to be saving more time and money than any other major portable power tool!



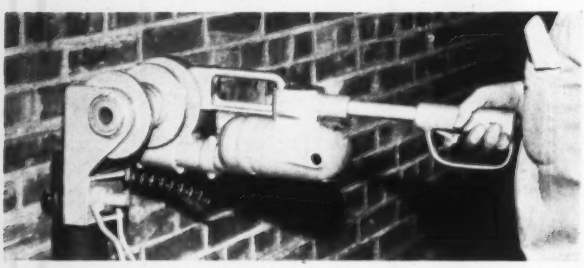
SIOUX NO. 1508 PIPE THREADER in use with No. 1511 Speed Reducer.



THREAD PIPE ON THE JOB, in a hurry. Once the unit is in place it only takes one hand.



DRIVING GEARED DIE STOCK with SIOUX No. 1508 Pipe Threader and No. 38002 Adaptor.



WIRE IS PULLED THROUGH CONDUIT with SIOUX No. 1508 Pipe Threader and No. 1509 Portable Winch.

Your SIOUX Power Pipe Threader will also thread bolts; drill; auger; and open and shut valves. (It's a versatile, portable power package!)

Look for SIOUX in the yellow pages under "Tools, Electric" or write to

ALBERTSON & CO., INC.

SIOUX CITY, IOWA, U. S. A.

AIR IMPACT WRENCHES • AIR SCREWDRIVERS • ELECTRIC IMPACT WRENCHES • DRILLS • SCREWDRIVERS • GRINDERS • SANDERS • POLISHERS • FLEXIBLE SHAFTS • PORTABLE SAWS • VALVE GRINDING MACHINES • ABRASIVE DISCS

IT MAKES SENSE !

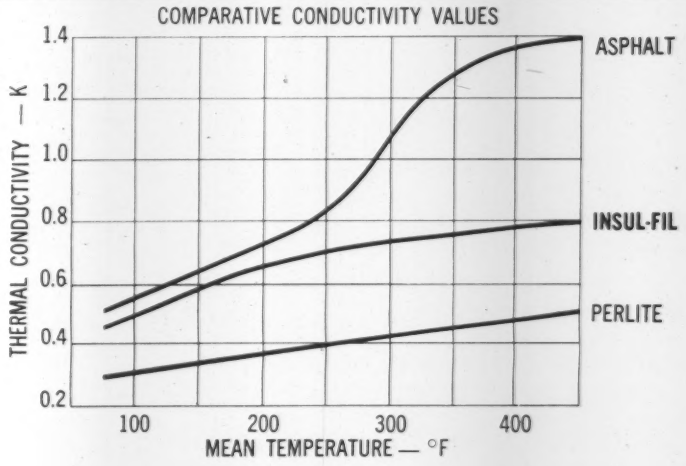
TO INSULATE UNDERGROUND PIPING WITH

insul-fil®

1 Introduction of a material such as expanded perlite into a granulated hard asphalt improves the insulating value of the blend.

2 Proper selection of asphalts by softening point to make up asphalt-perlite blends improves the insulating properties of the blend.

3 Introduction of an aggregate, such as perlite, into a granulated asphalt improves the mechanical properties of the blend once it is plasticized.



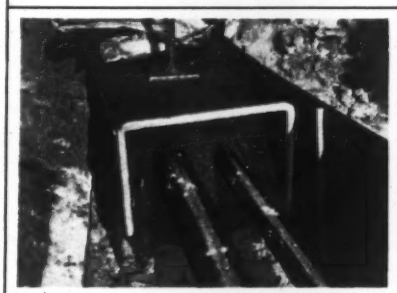
After years of extensive testing conducted at the Research and Development Department of The Atlantic Refining Company, these conclusions were presented in a Paper given before the American Chemical Society in Dallas, Texas, April, 1956. Since that time, hundreds of Insul-fil field installations have confirmed these conclusions.*

It is a well-known fact that the use of asphalt in construction created the necessity for the introduction of fillers (usually inorganic) of various types for the purpose of arresting the flow characteristics and improving the insulation value of the asphalts themselves.

The blend of hard granular asphalt and asphalt coated perlite gives Insul-fil its excellent insulating properties, water resistance and sufficient structural strength to the insulating body to resist normal soil stresses with the steam on or off.

An important Insul-fil development is the priming of the pipe with Accelerator #7591. The use of accelerator provides continuous adhesion of Insul-fil to the pipe, hastens consolidation, and gives additional protection against corrosion by galvanic action.

**Paper available on request.*



Insul-fil Is Simple To Install

Just pour it around the pipe to be insulated. Prod and tamp it in place and backfill. Heat introduced into the pipe forms the conduit.

Insul-Fil Company Inc.
250 Pettit Avenue
Bellmore, Long Island, N. Y.

Please send literature.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

insul-fil

The most efficient Granular Fill Type Insulation for Hot Underground Piping

Insul-Fil Company Inc. DIVISION OF: MIRACLE ADHESIVES CORPORATION, 250 PETTIT AVENUE, BELLMORE, LONG ISLAND, N. Y.

MSA reports on: A Vocabulary of Airborne Particulate Hazards

MSA hopes to stimulate through this discussion a clearer and more orderly interpretation of airborne particulate hazards. This report is directed to those of you in industry who have something to do with the moving and filtering of large volumes of air. A general knowledge of these terms will help us all communicate more effectively. Write us for help in your system recommendations.

DUSTS—Let's define dusts as mechanically generated particulate matter (usually found in the harmful size range of from 1 to 10 microns in diameter). *Nuisance or irritating dusts* have no known specific physiological response. *Fibrosis producing dusts* are local offenders, causing growth of scar tissue in lungs. *Toxic dusts* are general offenders, being systemic poisons. Toxic dusts are of two types: (1) not significantly more toxic than lead: limit of U. S. Bureau of Mines Schedule #21; and (2) more toxic than lead: materials such as Beryllium. *Radioactive dusts* include radioisotopes and inert carriers.

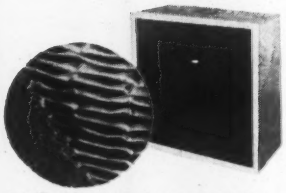
MISTS AND FOGS—Under this category falls liquid particulate (usually found in size ranges of from 5 to 100 microns).

METAL FUMES—Here lie the chemically generated solid particulates (usually generated in a size range of from 0.1 to 1.0 microns).

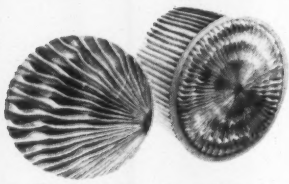
SMOKES—These particulates are also chemically generated but of organic origin (usually formed in a size range of from 0.01 to 0.3 microns).

LIVING ORGANISMS—Harmful living particulates are classified under this heading. And they in turn include:

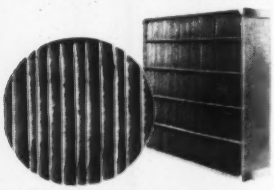
Bacteria: one-celled micro-organisms of ½ to 15 microns diameter size range. *Bacteriaphages:* .01 to .5 micron in diameter, depending on degree of clumping. *Virus:* .001 or smaller to 0.3 micron in diameter. *Pollen:* microspores from seed plants (usually found in the size range of from 10 to 70 microns in diameter). *Spores:* reproductive bodies of plants and some one-celled animals about same size as bacteria.



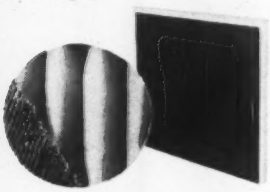
M-S-A® UltraAire* Space Filter
Light weight, fire-resistant, unusually strong, and ideal for high humidity service. Individually pre-tested and proved at least 99.97% efficient in removing particles of 0.3 micron diameter.



M-S-A® Cylindrical-Type UltraAire* Space Filter
Honeycomb-type fold without separators is admirably suited to cylindrical element construction. This shape is preferred for pressure systems. Weighs only one pound. Easy to handle. Inexpensive to ship.



M-S-A® Dustfoe* Space Filter
Offers the efficiency of an Electrostatic Precipitator without the high cost and without the possibility of arcing "blow-off." 85-95% certified efficiency on NBS Stain Rating.



M-S-A® Air-O-Kay* Prefilter
Impingement type panel prefilter which can be used oiled or dry to remove lint and other large airborne particles from the atmosphere. 60-70% certified efficiency on NBS Stain Rating.
*Trademark

Write for illustrated technical bulletins on M-S-A Space Filters related to your particular system problem. Ask an MSA Representative for system recommendations.

Fluid Purification Specialists for 45 Years

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pa.

Other Fluid Purification Equipment includes catalytic filters for jet aircraft cabin air; air separation plants; inert gas generators; space capsules; bomb shelters; air line filters; jet fuel and hydraulic fluid purification.

Anaconda Vibration Eliminator, 1½" I.D. x 17" installed in liquid fill line of a 9000-gallon LOX tank installed in a railroad boxcar by Lox Equipment Co.

When –297°F LOX hits the piping, Anaconda VE's absorb the shock

Damping vibration in the rigid piping of refrigeration and air conditioning systems is the job for which Anaconda Vibration Eliminators are designed. But every once in a while the basic properties of VE's are called on to handle another kind of tough job—a tribute to their high quality and dependability.

Lox Equipment Co., Oakland, Calif., makes unfired pressure vessels to hold liquefied gases. The company has to provide protection for valves and piping when liquid oxygen at –297°F or liquid nitrogen at –300°F begins to flow. To absorb thermal contraction and shock from sudden temperature swings that may go over 400°F, it has been using Anaconda Vibration Eliminators now for about four years. VE's have the mechanical properties and corrosion resistance needed, and have been doing a good, dependable job, according to Mr. Robert Hampton, general manager.

The inherent strength, toughness, and fatigue resistance of the true tin bronzes used in both the flexible tubing and wire braiding—and the sound design and construction of the entire assembly—are the reasons why Anaconda VE's stand up in severe service, year after year. Use them for lasting system performance in every air conditioning and refrigeration system.

Anaconda Vibration Eliminators—listed by Underwriters' Laboratories through sizes 4⅛" O.D. – are sold by leading air conditioning and refrigeration wholesale distributors everywhere. For folder, write: Anaconda Metal Hose Div., The American Brass Company, Waterbury 20. Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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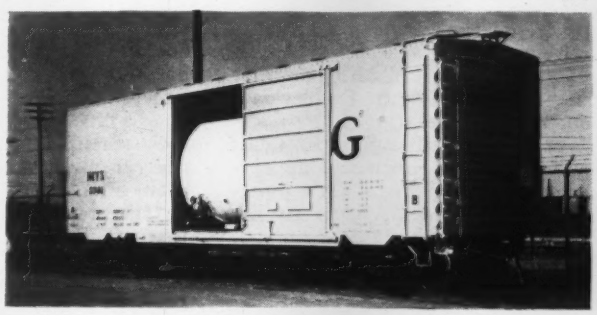
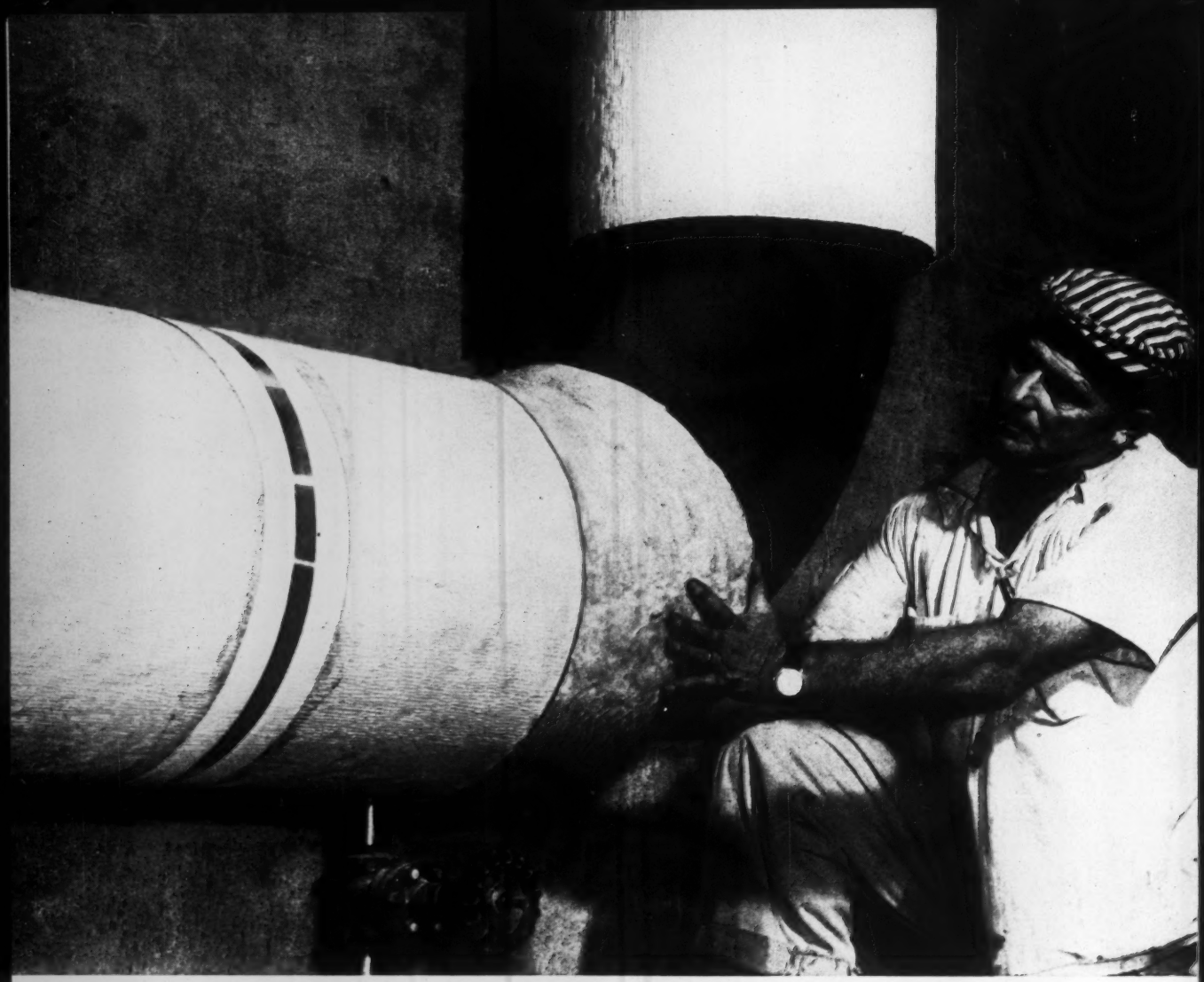


ANACONDA®

VIBRATION ELIMINATORS



try this on your pipe...

(it's Pittsburgh Fiber Glass Pipe Insulation)

Acme Insulation Company, Pittsburgh, did . . . on the piping job at Pittsburgh's new Gateway Parking Garage in Gateway Center. And here's what Acme owner Walter S. Peebles says about this installation:

"We chose Pittsburgh Fiber Glass Insulation for its efficiency, appearance and permanence. It's lightweight, handles easily, cuts readily with a knife, is quickly applied. There's a minimum of waste material.

"We've found that Pittsburgh Pipe Insulation holds its size and shape, does not effect the metal it covers, and has a fine record for low-cost maintenance. We used 8,300 ft of it on ½" to 14" pipe for underground heating, snow melting, chilled water lines, general plumbing, sill cocks and drain lines.

"It's probably the finest insulation that can be used, especially in subsurface locations."

FOR TOP THERMAL CONTROL, THIS IS IT! Pittsburgh Fiber Glass Pipe Insulation is a molded flexible hollow cylinder, slit along its length to provide quick application to pipes or tubing. It has high thermal efficiency for any type pipe insulating job and is surprisingly economical. You can get complete details from your nearest PPG Fiber Glass Sales Office, or by writing to *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Penna.*

SALES OFFICES: Atlanta, Attleboro, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Fort Wayne, Houston, Kansas City, Los Angeles, Louisville, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco and Washington.

FIBER PPG GLASS PITTSBURGH PLATE GLASS COMPANY

POWELL

WORLD'S LARGEST FAMILY OF

VALVES

performance makes the world of difference

POWELL BRONZE VALVES

Pictured here are a few valves offered by Powell to meet the demand for good, quality Bronze Valves. All kinds are available—gate, globe, angle, check, "Y", etc.—in all required sizes—for pressures from 75 to 2500 pounds.

The Powell Line includes valves in bronze, iron, steel, corrosion-resistant metals and alloys—just the right valves in the right sizes and materials to handle every flow control requirement, whether water, oil, gas, air, steam or corrosive fluids. Consult your Powell Valve Distributor—or write to us for illustrated literature.

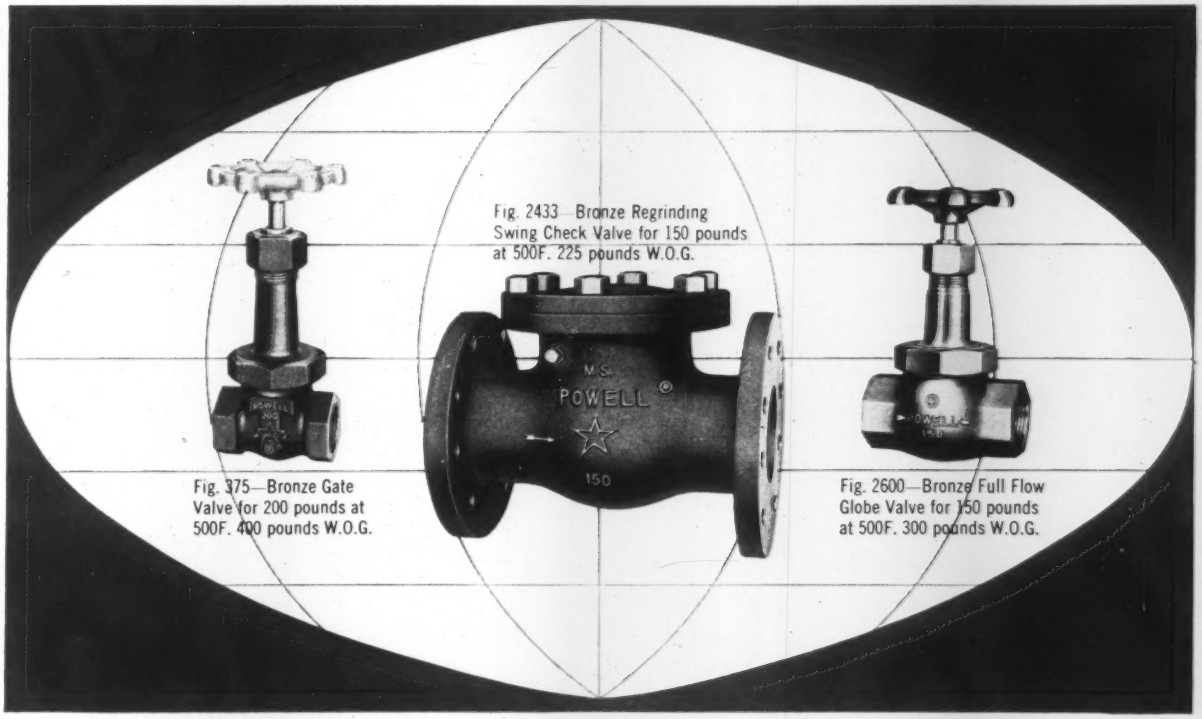
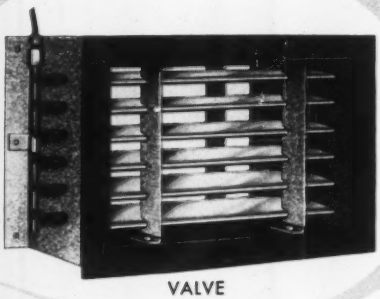


Fig. 2433—Bronze Regrinding Swing Check Valve for 150 pounds at 500F. 225 pounds W.O.G.
POWELL
150
Fig. 375—Bronze Gate Valve for 200 pounds at 500F. 400 pounds W.O.G.
Fig. 2600—Bronze Full Flow Globe Valve for 150 pounds at 500F. 300 pounds W.O.G.

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

again... CONNOR'S Creative Engineering produces another Beneficial Advance in

HIGH VELOCITY AIR DISTRIBUTION EQUIPMENT



VALVE

the series 45P VALVE ATTENUATOR

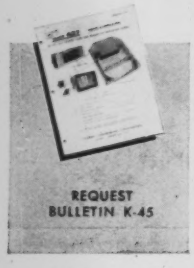
Designed especially for Dual Duct, Constant Volume Systems

Here's the new Kno-Draft Series 45P Valve Attenuator, designed especially for dual duct, constant volume high velocity air distribution systems—a product created by the same engineers who developed the unique Helical Spring Damper in '58 and revolutionary Pneumavalve in '59.

The Series 45P offers distinct application superiority over motorized valves because of these features:

- NO MOTORS, NO LINKAGE used—foolproof function through pneumatically activated airfoil valves and controls . . . no moving parts to loosen or wear . . . no future decrease in capacity owing to clogged perforations.
- Acute sensitivity to slightest variation in control pressure . . . no hysteresis.
- Flexibility of operation . . . constant volume operation normally, with fast warm-up when required.
- Positive mixing of hot and cold air . . . no stratification.
- Ultra-quiet operation . . . valve surfaces are flocked . . . all baffles and internal surfaces are lined with one-inch coated acoustical material.

As with all Connor products, the reliability of the Series 45P is backed by more than forty years of experience in the development and application of air handling equipment. For complete selection and application information on the Series 45P, request Bulletin K-45 from the Connor sales engineer near you, or from Connor Engineering Corporation direct.



REQUEST BULLETIN K-45

CONNOR... for Constant Comfort Conditions

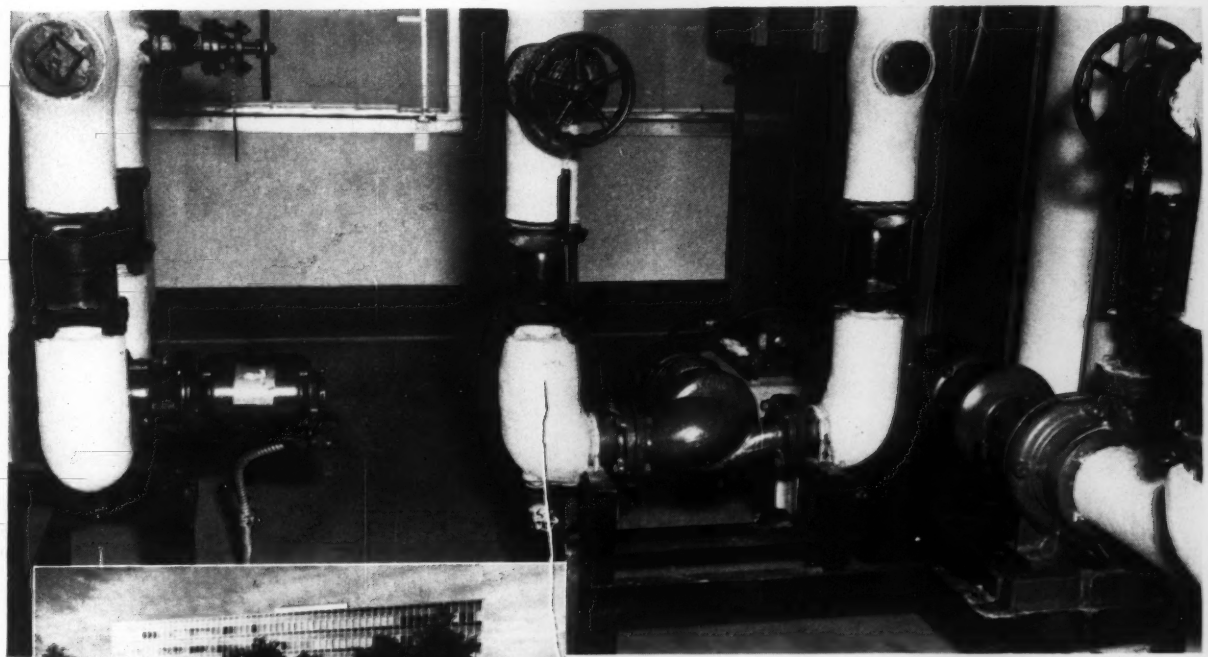
CONNOR ENGINEERING CORPORATION

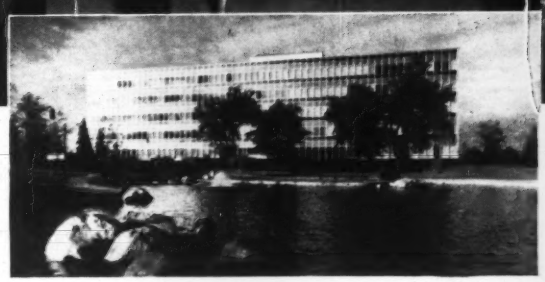
DANBURY • CONNECTICUT

CONNOR ENGINEERING CORPORATION

kno·draft®

high velocity air diffusers

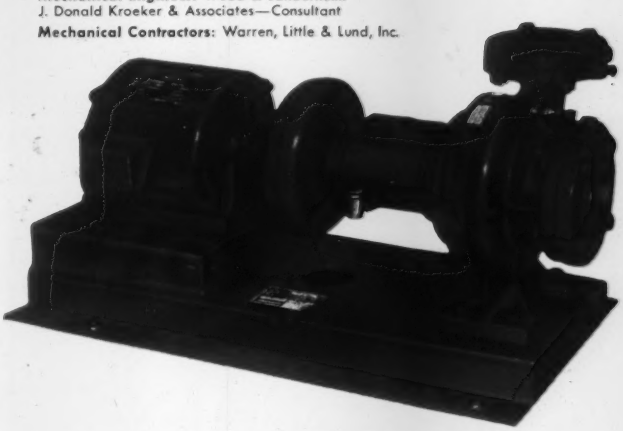




Washington Water Power Building, Spokane, Wash. and one of the pumping stations.

Architects: Kenneth W. Brooks, A.I.A.
Bruce M. Walker, A.I.A.
Mechanical Engineer: Wood & Landerholm
J. Donald Kroeker & Associates—Consultant
Mechanical Contractors: Warren, Little & Lund, Inc.

WORLD'S THIRD LARGEST HEAT PUMP INSTALLATION EQUIPPED WITH B&G® PUMPS



In this modern building, the third largest heat pump installation in the world provides 815 tons of refrigeration and 9,000,000 BTU for heating. The heat pump draws 1600 GPM from a deep well with the water being discharged to the river in winter and used for irrigation in the summer.

The heating and cooling system is a dual duct, high velocity system, with a separate zone and pumping station on each floor. Five B&G Universal pumps and 21 B&G Boosters provide the necessary circulating equipment.

The system employs the Primary and Secondary Method of Pumping developed by B&G engineers. This method materially reduces pump horsepower required and provides close temperature control, more comfort, lower operating and installation costs.

Send for free booklet on B&G System of Primary and Secondary Pumping.

B&G Universal and Booster Pumps are specially designed and built for systems using water for heating and cooling. They are distinguished by quiet, vibrationless operation and long failure-proof operation. They can be installed without flexible connectors or noise dampeners of any kind.

BELL & GOSSETT
COMPANY
Dept. GC-5, Morton Grove, Ill.

Canadian Licensee: S.A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

Easy as wrapping a bun around a weenie

LABOR COSTS FOR INSULATING LINES CUT IN HALF BY B.F.GOODRICH CELL-TITE INSULATION TUBING

EVEN when pipe has already been connected, B.F.Goodrich insulation tubing can be slit, snapped on and cemented in seconds. And, if you prefer, you can get it pre-slit for even faster installation. Slitting is unnecessary for new lines—it slips on straight or bent pipe as easily as a ring on your finger. Installation is so fast that labor costs for insulating pipe can be cut 50% or more over old-fashioned twine-wrapping, skirting and other slower methods.

B.F.Goodrich insulation tubing is made of a tough, flexible rubber with millions of uniform, non-connecting cells that seal out air and moisture. It can be used for insulating pipes carrying hot or cold liquids at temperatures ranging from —20°F to 200°F. Clean and easy to work with, doesn't rub off, chip or crumble. It comes in lengths up to 50 feet, so less joints are needed, scrap is reduced to a minimum.

This BFG insulation is also self-extinguishing, so it can be installed on copper tubing before sweat fittings are made—tubing is merely pushed back and held by clamps while joint is soldered.

Try this labor-saving insulation on your next job. For full information on BFG insulation tubing, call your B.F.Goodrich distributor, or contact *The B.F.Goodrich Company, 181 Derby Place, Shelton, Conn.*

INSULATION TUBING BY B.F.Goodrich

Bonus Life...Bonus Protection

from the Boiler Capital of the World

BONUS LIFE means longer life and less refractory maintenance made possible by Titusville's unique WTP design.

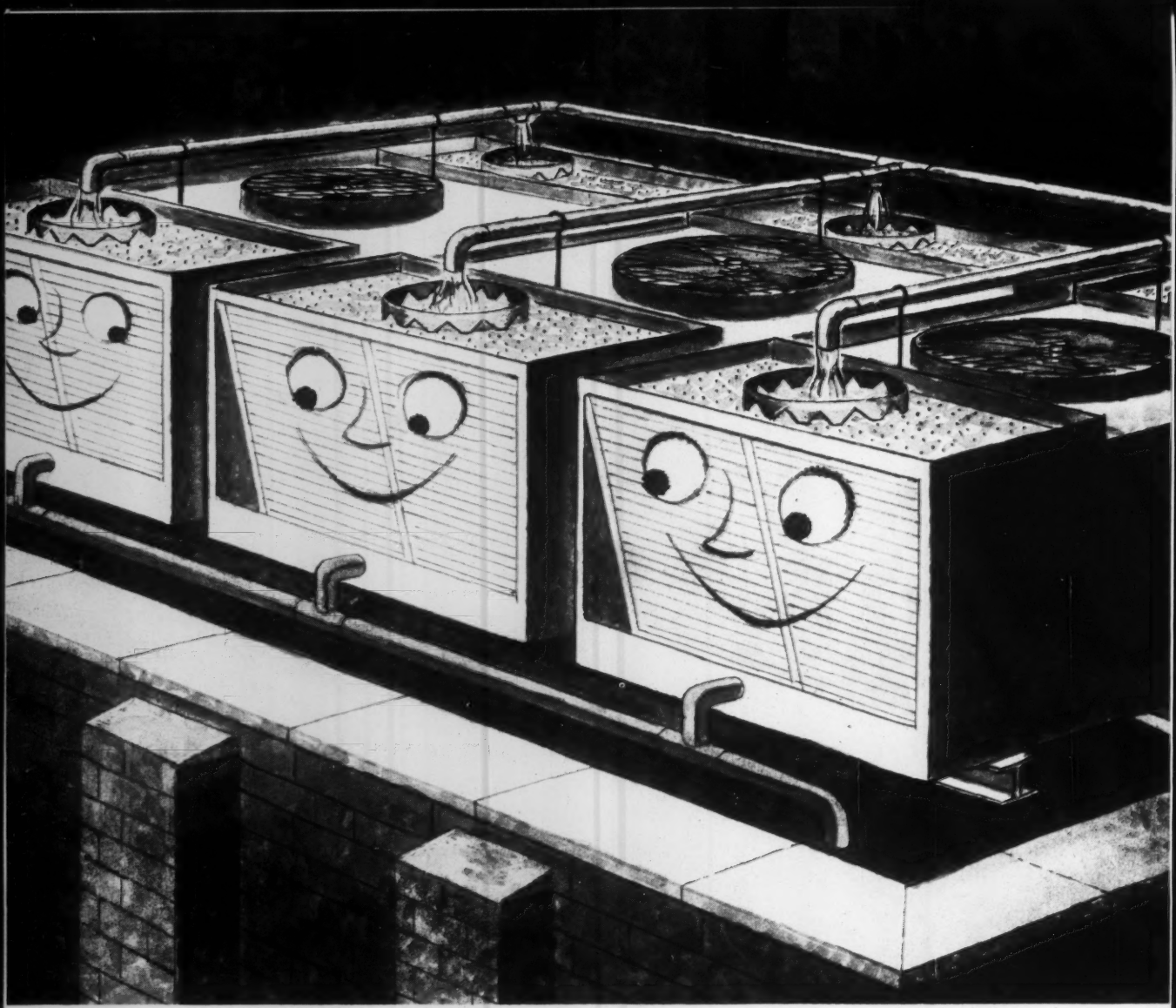
65% Black Surface Tube Area coverage on rear wall. Titusville's increased black surface tube area means less refractory maintenance through longer refractory life (less down-time for replacement) and a faster steamer.

BONUS PROTECTION (solves the H_2SO_4 problem). Most water tube steam generators operate intermittently. When dew point is approached at low fire condition, H_2SO_4 can form quickly in *single casing* boilers. Titusville WTP's *double casing* design (with insulation between) reduces temperature differential. *Result:* formation of H_2SO_4 almost entirely eliminated for many times more casing life.

VMA 6979

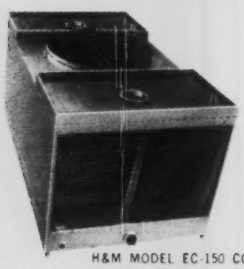
THE TITUSVILLE IRON WORKS COMPANY Division of Struthers Wells Corporation
TITUSVILLE, PENNSYLVANIA

For your **BONUS LIFE** and **BONUS PROTECTION**, specify **WTP** from Titusville



How to cut costs on a 450-ton cooling job:

Use three Halstead & Mitchell 150-ton cooling towers!



H&M MODEL EC-150 COOLING TOWER
WITH 10-GAUGE STEEL CABINET

How can three units be cheaper than one? Simple. Halstead & Mitchell packaged cooling towers come to you completely assembled and therefore less expensive to install. They operate at lower cost because there can be no wasted capacity; with step-control, you get capacity as you need it.

Furthermore, with "modular" units, you can place each tower near the equipment it's to be used with. This gives you closer control of water temperatures—another economy factor. Then, too, if one tower must be shut down, you can continue to operate the others.

The advantages go on and on: lower silhouette, lower rigging costs, and utmost flexibility—towers can be easily moved or supplemented as requirements change. And, like all H&M towers, these carry the exclusive 20-Year Guarantee on the wetted deck against failure due to fungus attack or rotting.

Contact your Halstead & Mitchell distributor for complete information on H&M cooling towers in 3- to 150-ton capacities. Or write Halstead & Mitchell Co., Bessemer Bldg., Pittsburgh 22, Pa.

HM

Halstead & Mitchell

Cooling Towers • Water-Cooled Condensers • Air-Cooled Condensers • Finned Coil Products • Air-Handlers

A-B QUALITY

ALLEN-BRADLEY
Solenoid Starters give

MORE MILLIONS OF TROUBLE FREE OPERATIONS

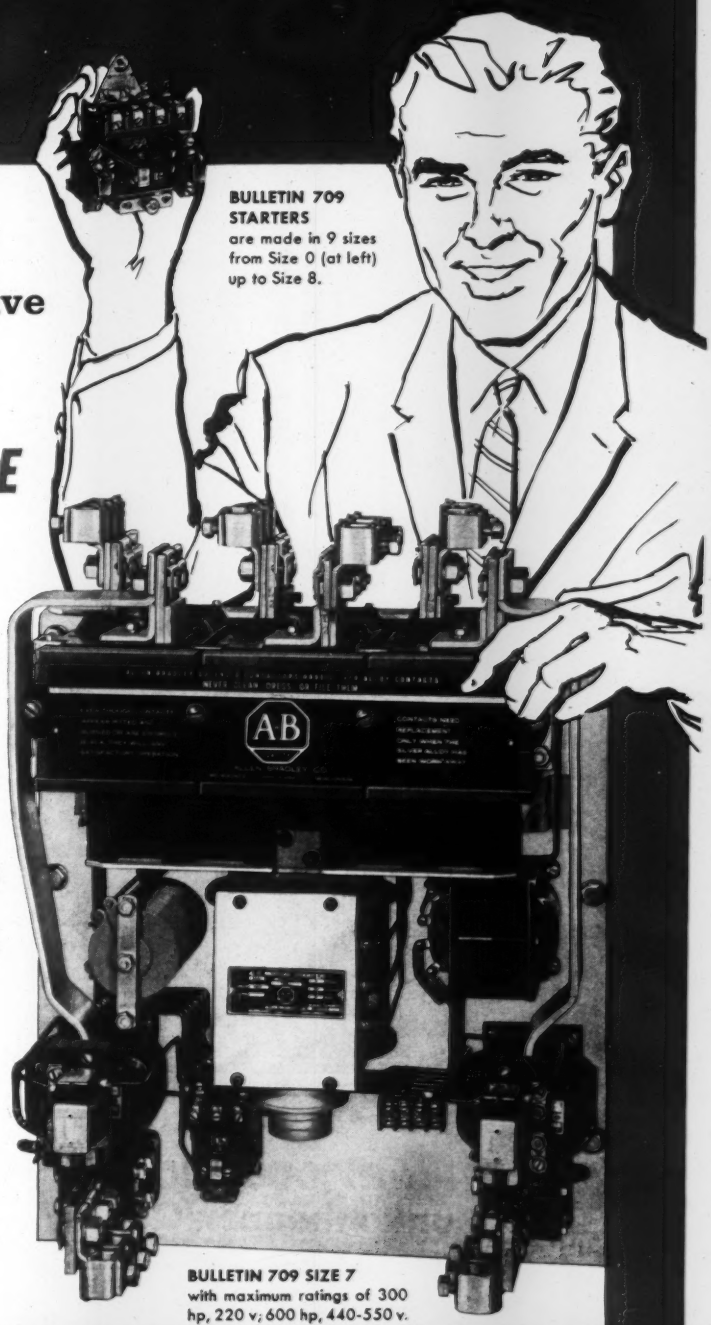
. . . and for good reasons

• ONE MOVING PART
With this simple solenoid design, there's virtually nothing to go wrong—all trouble-causing bearings, pivots, and flexible jumpers have been eliminated.

• DOUBLE BREAK, SILVER ALLOY CONTACTS
Allen-Bradley silver alloy contacts never require maintenance. They are always in perfect operating condition . . . and remain so until completely worn away.

• SIMPLE UP-AND-DOWN MOTION
The virtually frictionless, straight line vertical motion provides uniform contact pressure at all times—and assures consistent, rapid operation of the contactor.

• RELIABLE OVERLOAD PROTECTION
All A-B starters are equipped with two permanently accurate and reliable overload relays that protect motors against "burnouts." Three overload relays can be furnished.



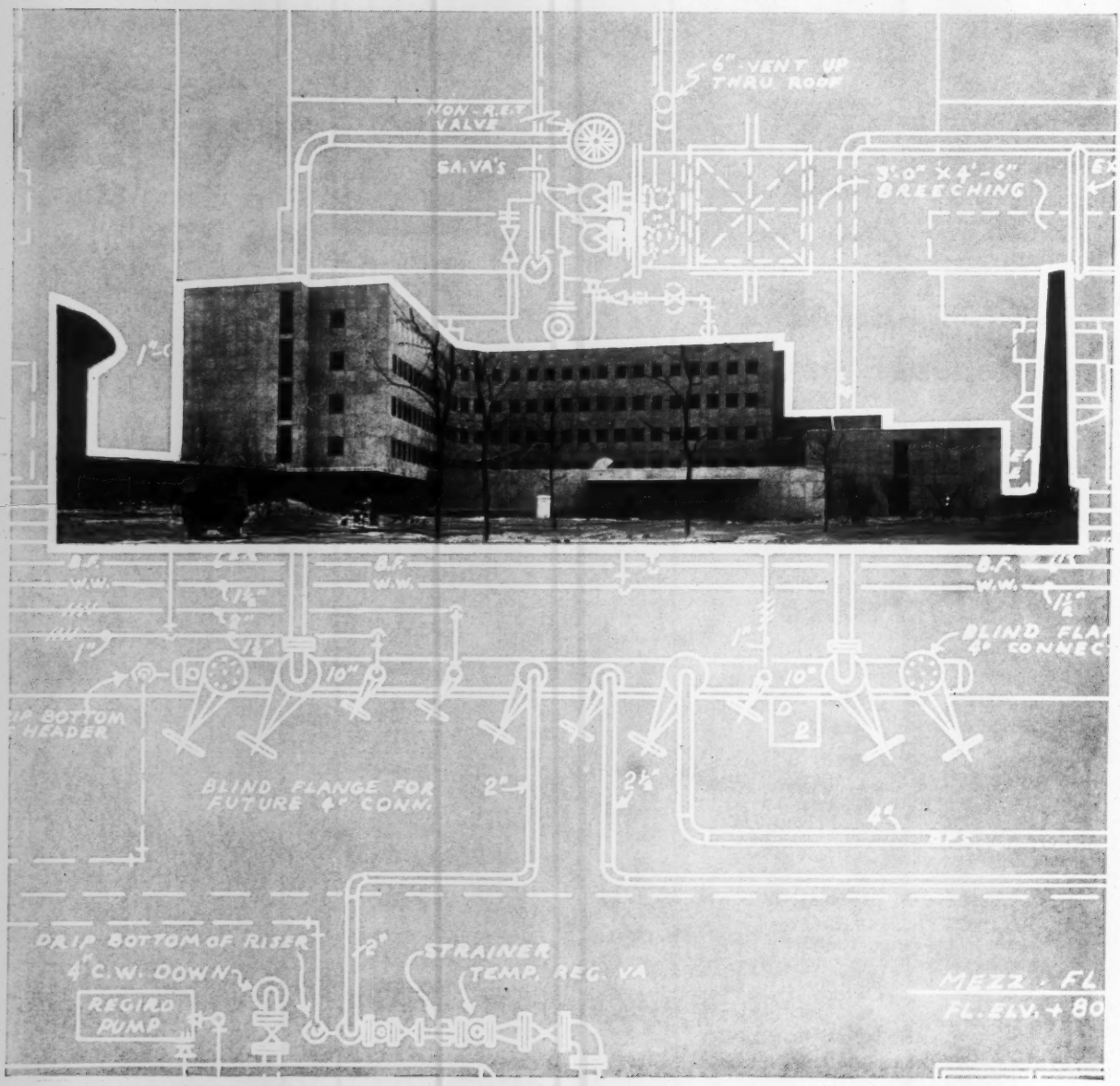
BULLETIN 709 STARTERS are made in 9 sizes from Size 0 (at left) up to Size 8.

BULLETIN 709 SIZE 7 with maximum ratings of 300 hp, 220 v; 600 hp, 440-550 v.

ALLEN-BRADLEY

QUALITY MOTOR CONTROL

Allen-Bradley Co., 1336 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



Founder: The William K. Warren Foundation
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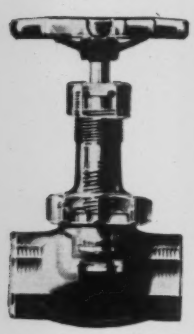

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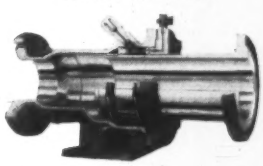

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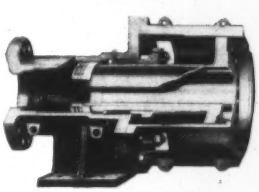

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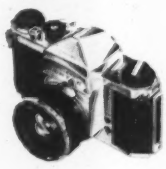

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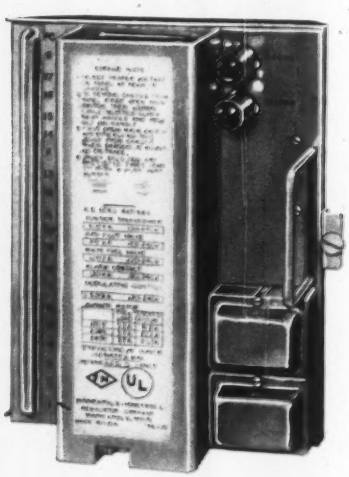

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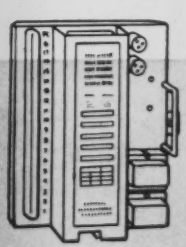

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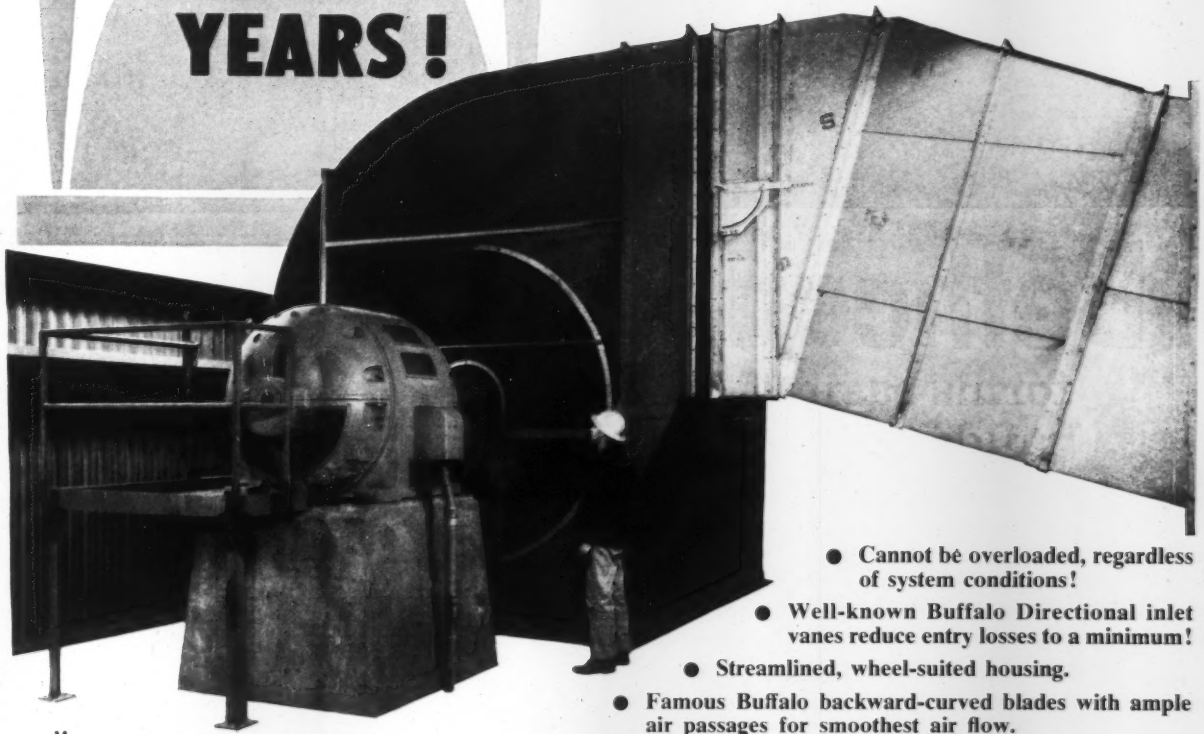

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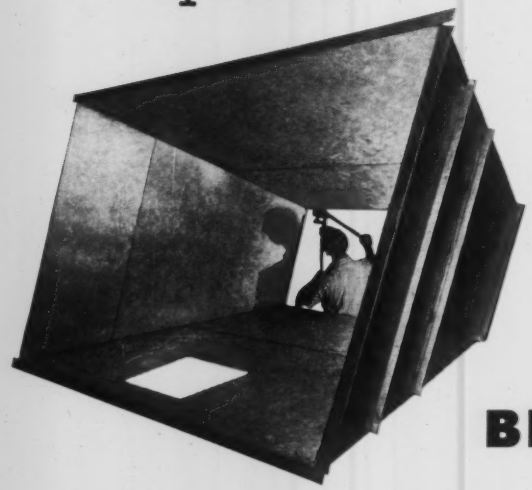

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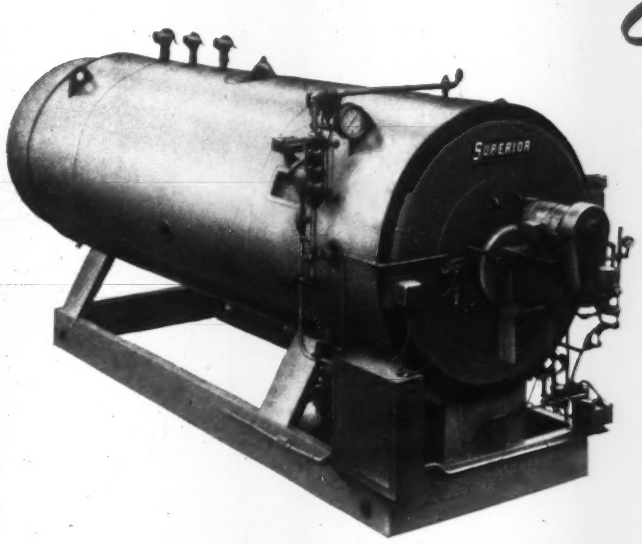

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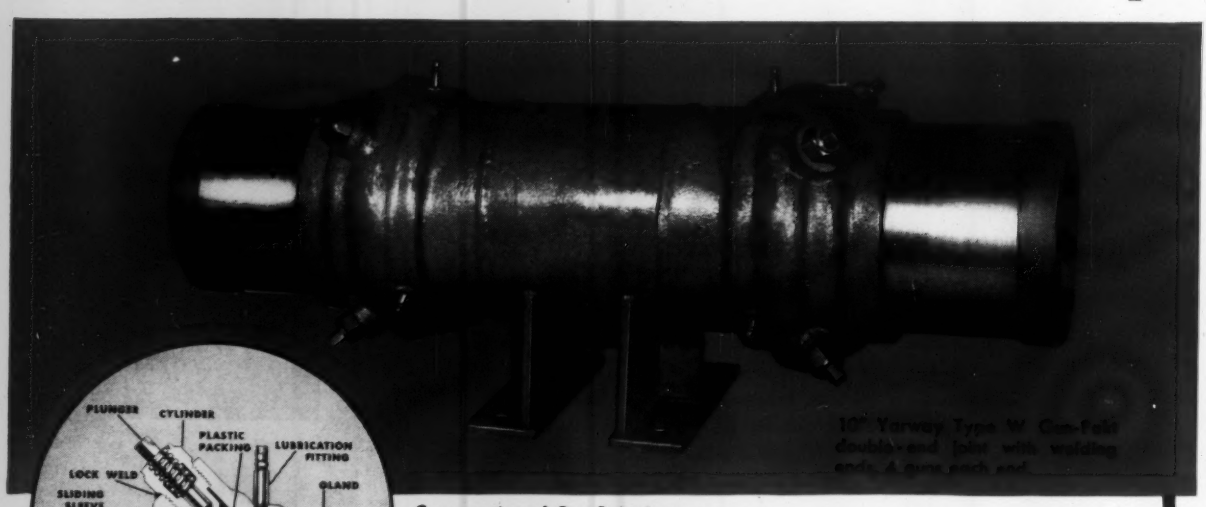

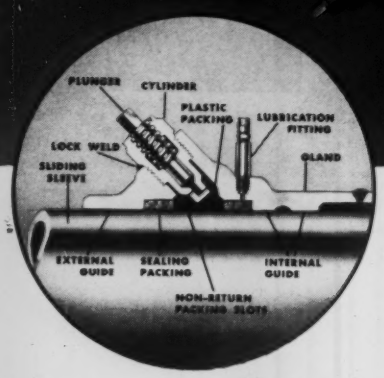

Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

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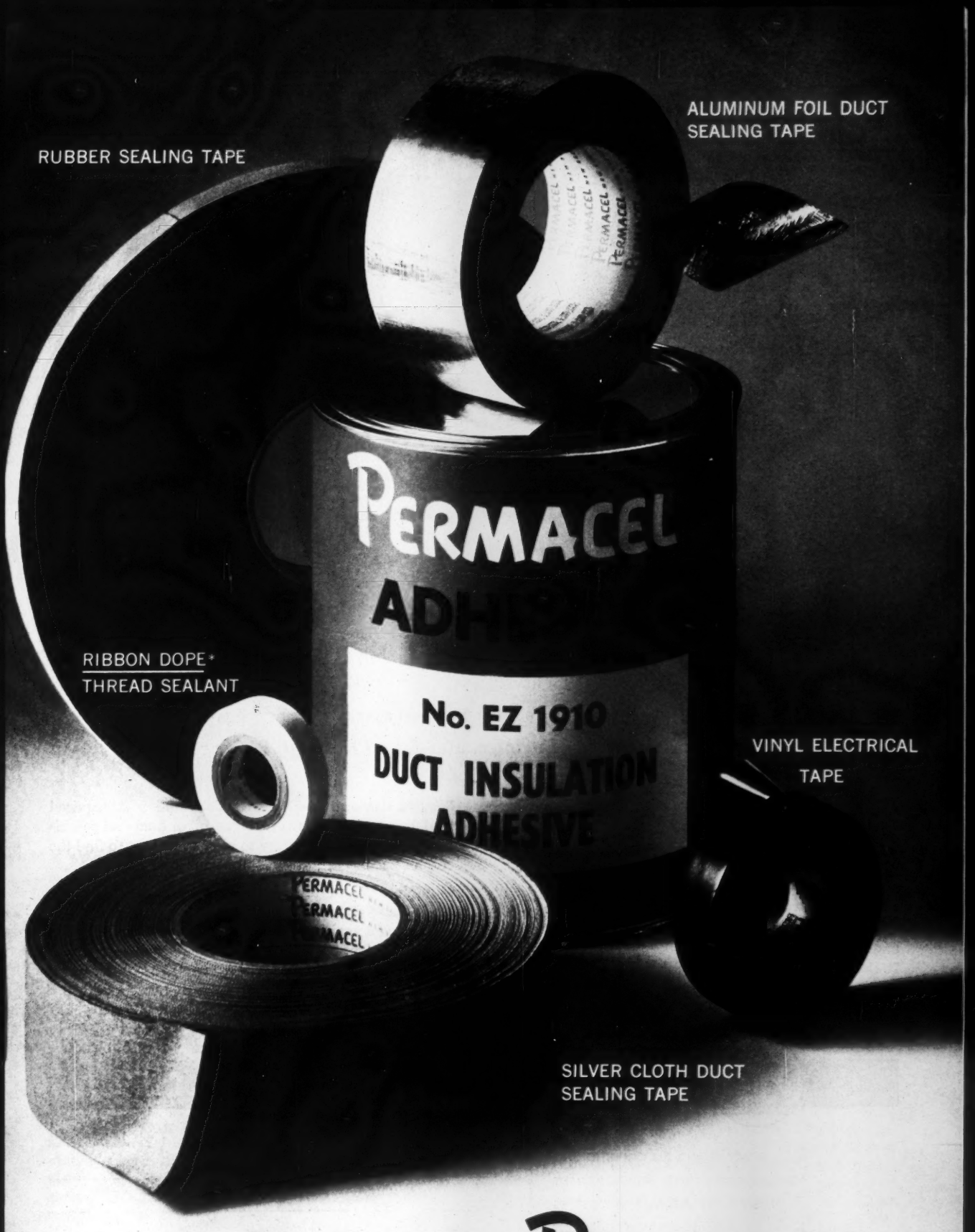

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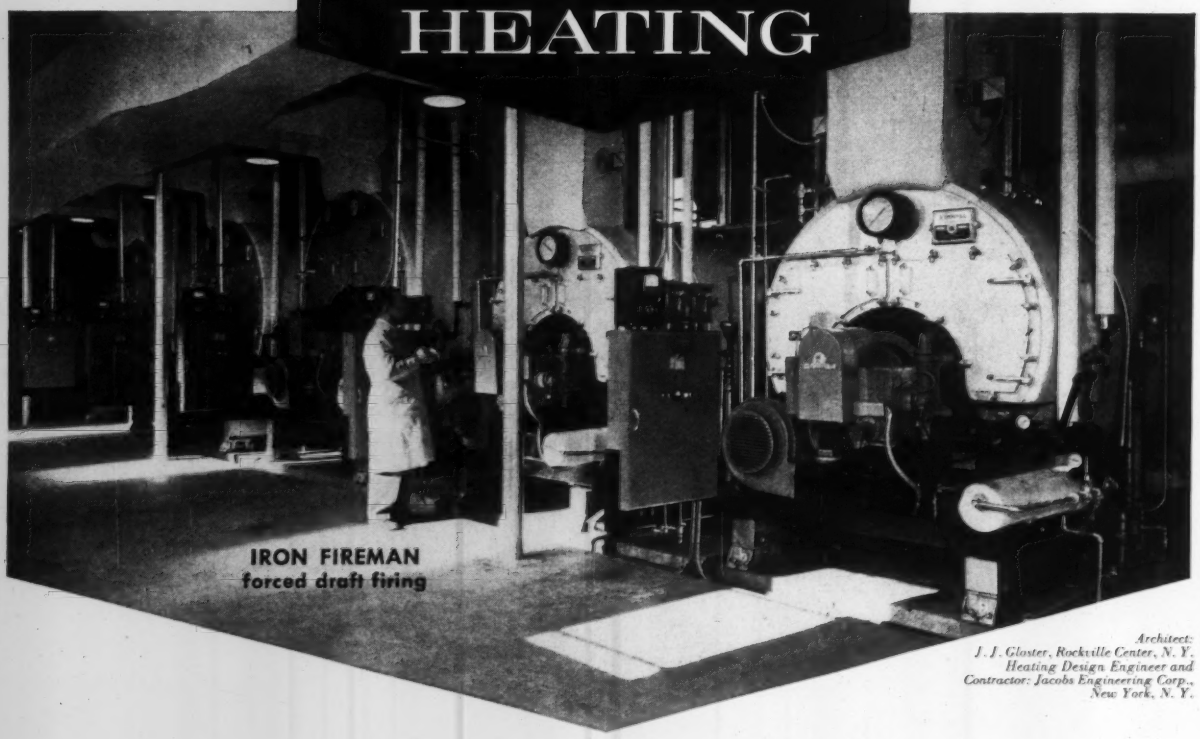

Architect:
J. J. Gloster, Rockville Center, N. Y.
Heating Design Engineer and Contractor: Jacobs Engineering Corp., New York, N. Y.

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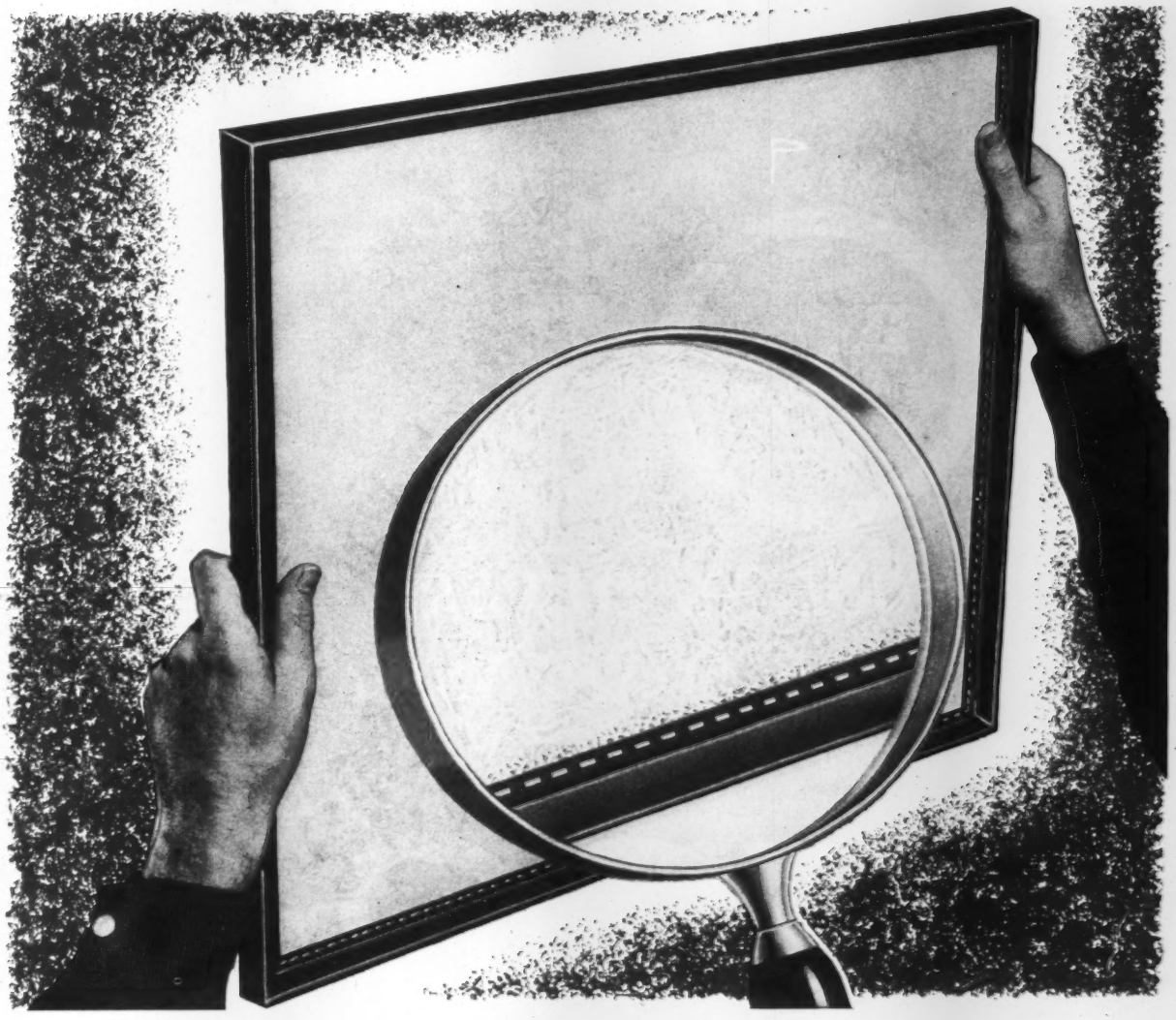

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With Minor Exceptions, Squaw Valley Installation Performed as Designed

WITH REFERENCE to my article, *Olympic Heat Pump Installation Warms Spectators, Melts Snow* (February), I would like to mention that the system was finished and was in operation with all facilities functioning at the time the article was published.

In spite of the fact that there is no precedent for some of the design criteria, we have found that in almost every instance the systems perform as originally designed. Elimination of roof snow operates a little differently from anticipated in that it is necessary to build up about 24 in. of 15 to 20 percent moisture snow before there is a slide-off. The friction coefficient of the roof is such that the larger weight and mass is required.

We also have found that it is necessary to paint a white layer in the ice surface on the rinks to reflect sun heat. The rinks here are at an altitude of 6200 ft. This mountain air is very clear. Test runs show that heat gain can be as high as 183 Btu per sq ft per hr with a dry bulb temperature of 60 F. Use of the white painted intercepting layer in the ice reduces the sun load from 25 to 35 percent.

The architects on this project were Corlett & Spackman, and Kitchen and Hunt. Also, the basic refrigeration and brine installation work was done by Gay Engineering Co.

DAN VANDAMENT
Vandament & Darmsted
Consulting Engineers

Results with Shallow Concrete Ducts Have Generally Been Unsatisfactory

WILLIAM B. KOERNER'S article, *Heat, Ventilate New High School Campus Many Different Ways* (December 1959), is very interesting. The only comment I offer is in regard to the installation of mains in concrete pipe with removable precast concrete covers.

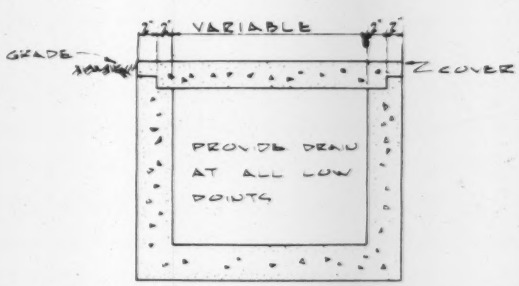
Past experiences I have had with shallow concrete ducts with removable covers have generally been unhappy ones. It is difficult to get covers which are completely watertight. Rain and melted snow somehow manage to get into the ducts, wetting the lines. In some cases, mud and debris have been carried in, necessitating fairly frequent and extensive cleaning.

We found that direct burial of insulated and jacketed lines, surrounded by an insulating concrete was one of the most economical and satisfactory methods of installing distribution systems if walk-in tunnels were not provided. Where we already had the problem of eliminating flow of water and mud in shallow ducts, we filled the duct with such a concrete and surfaced it with an asphaltic compound.

WILLIE HAMMER
Chief, Installations Branch
Ordnance Weapons Command
Rock Island Arsenal

THE AUTHOR'S REPLY—Mr. Hammer's suggestion on the use of an insulating concrete has already been tried in the United Kingdom on several air bases. The difficulty encountered with this type of installation was that after a few years it was apparent that there were leaks in the system. The leaks themselves turned out to be not only very difficult to locate but also very costly to repair as the concrete had to be chipped away before the joint could be repaired.

I do not believe that the use of concrete ducts with precast concrete covers for installing heating mains



1 THIS DUCT CONSTRUCTION is currently being used for Air Force base underground heating mains

underground is the ultimate solution. But, with the materials available at this time, it seems to be the best we can do.

Other methods of installing underground heating mains are being investigated at this time, but as yet have not been approved for use by the U.S. Air Force in the United Kingdom.

Fig. 1 is a sketch of the type of duct which is currently in use on Air Force bases for underground heating mains.

WILLIAM B. KOERNER
Mechanical Engineer
Daniel, Mann, Johnson & Mendenhall
Grad Engineering Associates
Seelye Stevenson Value & Knecht
Architect-Engineer Joint Venture

Choice of HTHW for Air Force Bases Has Stimulated Its Widespread Use

I WAS very interested in the excellent HPAC Engineering Data File, *What to Consider When Designing High Temperature Hot Water Heating Systems* (January). There seems to be no doubt that the impetus for the use of HTHW in this country was greatly stimulated by the decision of the U.S. Air Force to install HTHW for the extensive systems required by its air bases.

It should be mentioned that the man who originally convinced the Air Force and the Corps of Engineers to try HTHW was Paul Geiringer. He formed the American Hydrotherm Corp. to specialize in this method of heating.

The HTHW heating system for Limestome Air Force Base (now Loring Air Force Base), which he designed in 1947, was the first Air Force installation using HTHW. It was designed as a cascade type of system, largely because forced circulation boilers were not at that time readily available in the size required (75 million Btu per hr units were used). This plant now has an installed capacity of 450 million Btu per hr.

After the successful operation of the Limestome system, the Air Force entrusted Mr. Geiringer with the design of its second HTHW central heating plant at Lockbourne, Ohio. This uses forced circulation boilers and the dual-pump system, with steam pressurization.

The plant was designed as inexpensively as possible to establish the fact that HTHW systems can cost less in initial investment as well as in operating costs. It was a relatively small plant, including two 32 million Btu per hr boilers in the original installation. However, it was designed for expansion, and the plant has since been extended to eight boilers. Over 250 buildings are served, and some are well over two miles from the heating plant.

The success of this second HTHW installation led to the design of HTHW systems for McGuire, Dover, Plattsburg, and Mountain Home Air Force Bases within the same year, 1953.

The Air Force issued a directive that HTHW should be used in all future bases requiring extensive systems, and the Corps of Engineers contracted with Mr. Geiringer to write the *Manual of Design Criteria for HTHW Heating Systems*.

From that time, the application of HTHW has increased at a very fast rate, since the claims which had been made for this system had been proven in practice.

There are a few points in the January article with which I should like to take issue, and some points which perhaps require further clarification:

The drawings show check valves in the heating system returns. These are not used in any American Hydrotherm designs, and are, in our opinion, neither necessary nor safe. Check valves increase the hazards associated with water hammer and should be avoided, except, perhaps, where pumps are operated in parallel. When used, they should be slow-closing valves.

A number of HTHW systems have been designed incorporating practices common in the low temperature water field, with sometimes disastrous results. In many cases these have prevented the system from delivering heat to all of the buildings. Three-way and bypass valves result in higher return temperatures at low loads, constant circulation at all loads, and, usually, circulation far in excess of design.

The questions of balancing and hunting of control valves are mentioned. The Air Force installations have not required balancing other than that provided with properly designed control valves. Hunting of control valves is inexcusable with properly selected and adjusted control instrumentation.

Certainly, one of the great achievements of the "fabulous fifties" was the development of HTHW from a relative novelty in this country to a highly favored method of heating.

FLOYD HASSELRIIS
Chief Engineer, Industrial Div.
American Hydrotherm Corp.

Lauds Design of Eastman Kodak's Process Air Conditioning Systems

THE ARTICLE, *Rooftop Air Conditioning Systems Keep Photo Supplies Fresh*, by L. V. Quadrini (November 1959), is very interesting. In general, the design of Eastman Kodak Co.'s air conditioning is above average in all respects.

Rooftop equipment locations are to be preferred over ceiling-hung units in most installations because they usually make it easier to service filters, fans, coils, etc. Where large systems are involved, the alternate choice is an equipment room located on the floor or in a basement. Such installations are usually more

costly. Winter conditions, however, make rooftop locations a problem for the maintenance men. Some form of shelter should be provided for these filter changing operations. A penthouse is ideal, though somewhat costly. An oversized sheet metal housing could serve the same purpose at less cost.

Two other items should not be overlooked for rooftop installations: One is a good system of wooden catwalks to protect the roof from damage from heavy traffic. The other is a lighting system to provide good visibility for the maintenance men.

The use of package and built-up systems has been well thought out in this job. It appears that an economic study was used as the basis for these decisions. Flow-through systems with deep bed pocket air filters provide an unusually high degree of air cleanliness. The higher initial cost of such equipment as well as its higher operating cost should be justified by the definite need for above-average results.

Exposed, but insulated steam lines will present no freezing problems, provided steam pressure is maintained continuously and the system is properly trapped. Compressed air lines, however, are troublesome even when insulated. It is usually necessary either to dehydrate the air or to steam trace the lines in order to prevent freezing of the condensed vapor.

The description of the two-stage air handling equipment for the installation's western system is a little confusing. A little more data on what is meant by the "correct conditions" in the first system and "cooling and dehumidifying to specifications" in the second would be helpful.

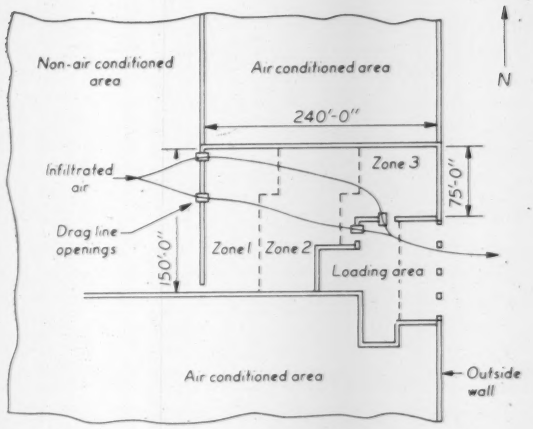
Use of two brine temperatures is economically sound. It is more costly to operate cooling equipment at lower temperatures. Therefore, the use of the highest possible brine temperature which will do the job is to be desired.

I would like to commend the engineers at Eastman Kodak Co. for doing such an excellent job in this "grief beset" field of air conditioning. These quality installations certainly enhance the prestige of the engineering profession.

W. S. Maxim
Chief Mechanical Engineer
Abbott Laboratories

The author's reply—Mr. Maxim's favorable comments are appreciated. As to the more detailed information he desires regarding the operation of a three-package unit installation for one of the storage areas, Fig. 1 depicts the product storage room which is maintained at 60 F and 50 percent RH. The cooling load is handled by a package unit type central station air conditioning system in each zone. These units are located on the roof.

The unconditioned infiltrated air easily traverses the room through the conveying drag line openings to the large truck doors in the loading area.



1 PRODUCT STORAGE ROOM is kept at 60 F, 50 percent RH

Under normal conditions the first unit must do additional dehumidifying and cooling to counteract this infiltration in order to hold Zone No. 1 at 60 F and 50 percent RH. The second unit functions as if no unconditioned infiltrated air were present.

But, under abnormal conditions during a few hours of the year when the wet bulb temperature of the infiltrated air exceeds 75 F and/or when there is an unusual amount of this air, the first system is unable to maintain the specified conditions in its zone. As this air passes into Zone No. 2, the second unit is called upon to perform additional dehumidifying and cooling to maintain specified conditions in its zone. In all cases the third system functions normally.

This design accomplishes better overall control in maintaining the area at 60 F and 50 percent RH than did one central system.

L. V. Quadrini
Mechanical Engineer
Eastman Kodak Co.

Test Specimens Permit Evaluation Of Filming Amines on Corrosion

The article, *Filming Amine Inhibitors Control Corrosion, Improve Heat Transfer in Steam Heating Systems*, by Malvern F. Obrecht (November 1959), contains a good general summary of the methods of controlling condensate corrosion and improving heat transfer. We have had the same general experiences going back to the time when reduction of carbon dioxide was considered the most important method of minimizing condensate system corrosion, through the widespread use of neutralizing products, and up to development of treatment with filming amines.

Costs are always an important consideration. Elaborate pretreatment equipment is not economically sound in many cases, because the filming amines alone will often do the job better.

Work with condensate corrosion testing has led us to adopt the use of 1 × 2 in. preweighed test specimens. These enable a rapid evaluation of the overall surface weight loss as well as visual examination for the presence or absence of an adequate protective film. Adjustments in feed rates can be made on this basis. The specimen surfaces demonstrate whether the attack is in the form of generalized etching due to dissolved carbon dioxide or pitting associated with oxygen. Specimens, when vulnerable, further serve as a good method of pinpointing leakage of oxygen into the condensate. Where corrosion rates are found to be in excess of approximately 25 mg per dm^2 per day, filming amine treatment is recommended.

Contrary to published literature on laboratory tests, field results show that residual protection varies after filming amine treatment has been discontinued. Iron and copper tests designed to monitor condensate corrosion do not show an immediate increase. Some time is required before these values again begin to pick up. This is significant since it demonstrates that, even though a continuous feed is the best method of introduction, a temporary halt in treatment will not result in immediate deterioration of the protective film. Thus, some degree of standby protection is afforded in systems which operate intermittently.

HUGH E. CARR
Chemical Product Engineer
Hagan Chemicals & Controls, Inc.

Asks for More Details Leading Up To Refrigerant Piping Decisions

I WOULD like to comment on Herman Vetter's article, *What Are We Paying for High Velocity in Refrigerant Piping Design, Operation?* (January). Based on the first paragraph, it is assumed that the material contained in the article is based on ammonia compressor operation. Even so, the points made in the article apply as well to other gases.

Although not mentioned as such, the author's data assumes at least dry gas leaving the evaporator. Depending on design, this may not always be true, such as with very light loads resulting in low boiling turbulence in the evaporator and very high loads when liquid carryover might take place.

In sizing piping for any purpose, among other things the economics should be considered, i.e., extra cost *vs* savings. This is not touched upon specifically, but again it must be assumed such a study was made when, in the author's example No. 3, an 8 in. pipe was substituted for a 4 in. pipe. Much value could be added to the material if a table showing pipe size *vs* operating savings were included to illustrate why an 8 in. pipe was selected as a replacement instead of a 6 in. or a 10 in. size.

In example No. 4 the cascading of the two brine pumps seems to me like improvising until a correct pump could be obtained and installed. The efficiency of the pumping system would be very low, at roughly 50 percent. Without the benefit of details, I would suggest that a correct replacement pump could be justified on the long term savings in power.

The author mentions the installation of a weir in a brine tank to measure brine flow. His brief statement indicates that the brine may be continuously exposed to ambient air. If so, calcium chloride brine would become acidic to create a serious corrosion problem in steel pipe lines, heat exchangers, etc.

The discussion regarding the use of a large (12 in.) uninsulated *vs* a 4 in. insulated line is very interesting and seems entirely feasible for a straight run of pipe. It would be interesting to know whether insulation is used at elbows or other fittings that may have been in the line. It would seem that there would be sufficient turbulence at these areas to cause frosting of the bare metal.

I believe Mr. Vetter's article is informative and contains valuable data. My comments are in no way intended to be critical, but rather are intended to suggest clarifying a few "between-the-lines" hints. Mr. Vetter is an engineer of long standing. I do not know him personally, but I respect his judgment. For the benefit of some of the younger engineers, I think Mr. Vetter would do them a service if he would provide a little more detail leading up to the decisions reached in the four illustrative examples.

JAMES H. SHAW
Director
Laboratory Services Dept.
Research Center
Carrier Corp.

THE AUTHOR'S REPLY—When the piping is designed for low velocities, the condition of the vapor leaving the evaporator is slightly superheated. It is mainly when high velocities prevail that entrained liquid may be present in the vapor. We had one case where the suction vapor was saturated. But this was due to the liquid being fed into the evaporator at high velocity. In this case the velocity of the mixture of liquid and flash vapor was 4000 fpm, causing the liquid to enter the evaporator in the form of mist. This was corrected by enlarging the connection and reducing the velocity to 860 fpm.

If Mr. Shaw would be more specific I would be pleased to answer his "between-the-lines" questions.

In reply to his comment in regard to cascading the two brine pumps, this was done because it was not discovered until the budget was approved that the pumps were improperly selected. While this is not an efficient method, we got better results by doubling the volume of brine circulated. We got better than 60 percent efficiency from the brine pumps.

HERMAN VETTER
Vetter Engineering Co.
Industrial Consulting Engineers

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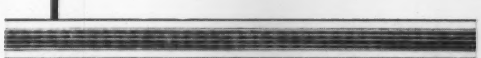
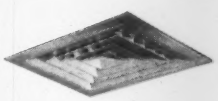


STRIPLINE — Slot Type Diffusers



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question of the month

"Would Stainless Steel Coils Solve Oil Piping Problem?"

This question was asked previously in Heating, Piping & Air Conditioning and is repeated here, along with answers that have been received from readers. Other solutions or comments for publication are invited.

"In the last few years, a number of heating projects using much underground piping have been installed with high pressure, high temperature hot water as the heating medium.

"A local supplier markets a heat transfer oil which is suitable for temperatures up to 600 F in a closed circuit and at atmospheric pressure. This fluid seems to offer many advantages. The main disadvantage appears to be its viscosity at temperatures below 10 F and its adverse effects on copper. Stainless steel coils could be substituted.

"Has any considered thought been given to such a substitution? If so, what possible pitfalls may we expect? Are there any typical installations? This method seems to eliminate the expansion and corrosion troubles associated with water.

"Information from readers will be appreciated."—R.C.M.

Seamless Steel Pipe Will Do the Job Unless Subject to External Corrosion

I HAVE HAD long experience with hot oil circulation heat transfer systems and feel qualified to answer R.C.M.'s question.

Hot oil is a stable and very satisfactory medium of heat transfer where a system is properly designed and operated. It has been the solution to many industrial processes. The proper flow velocity is important and so are suitable constant volume pumps, correct expansion tanks, and controls.

Oil does have a bad effect on copper. Therefore, for normal use, there is nothing better than seamless steel pipe of ASME code quality. I have always used this, except where some special corrosive material was being heated by the coils; that is, where the corrosive agent was external to the pipe and not due to the oil itself.

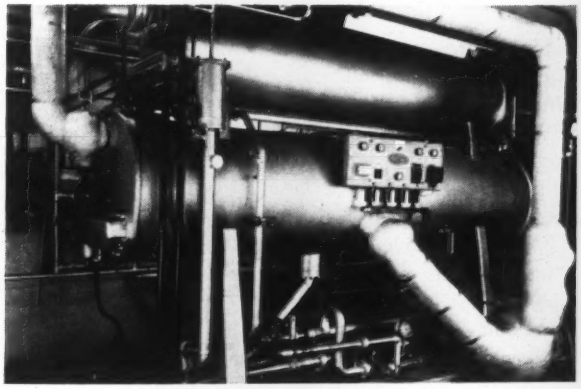
In this respect it is exactly the same situation as for hot water. However, the internal surface of steel pipes is not affected by hot oil. Stainless steel is satisfactory wherever plain steel would be corroded.

Some oils have very high viscosities at low temperatures. These should not be used. There are better types that have satisfactory viscosities and are better heat transfer agents than the older types of heavy lubricating oils that were originally used for heat transfer. At high temperatures, they all have very low viscosities, but some have more stability than others.

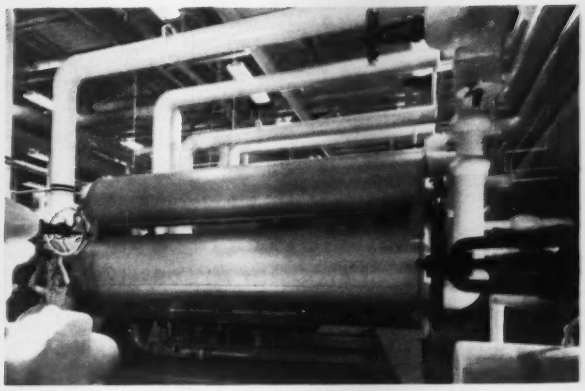
The great advantage of oil as a high temperature heat transfer agent is its low pressure. Up to 600 F it can be operated at atmospheric pressure. Above that, a small pressure of neutral gas, such as nitrogen, can be used.

LEE P. HYNES
Electrical and Mechanical Engineer

(Continued on page 102)



FOURTEEN YEARS AGO, the first Carrier Absorption Refrigeration Machine was installed in the Sealright Corporation's plant in Fulton, New York. This pioneer machine has been in continuous operation ever since.



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question of the month

Oil Systems Require More Liquid, Greater Heat Transfer Areas

HEAT TRANSFER oils have been used successfully for relatively small installations, such as heating press plattens, callender rolls, autoclaves, kettles, and various types of heat exchangers. R.C.M. does not state the type of service and heat load, nor the size and geometry of the system.

Compared with water, most oils have lower heat capacitance (specific heat) and reduced conductivity values. These disadvantages necessitate use of increased liquid quantities and either greater heat transfer areas and/or higher temperature differences. Larger storage and surge tanks may be needed; the former for holding oil during shutdown and system drainage periods.

Unless the oil contains additives, decomposition at high temperature may result. Also, vapor formation is possible, leading to a reduced heat transfer rate and possible pumping problems.

Although stainless steel is unaffected by most oils, contamination of the latter, resulting from a leaky tube or pipe joint, is conducive to corrosion of carbon steel and some nonferrous metals. In addition, a leak or mechanical failure of an oil circuit presents a messy situation.

The additional first cost for greater fluid quantities, possible need for larger pumps, and increased heat transfer areas as well as additional energy requirements for circulation, generally detract from the apparant advantages of using oil for this type service.

H. B. WAYNE
Consulting Engineer

READER ASKS—

"What's the Best Way to File Technical Articles and Data?"

"I know this question has been asked before as the Question of the Month, and I have read many answers to this question which have all been very helpful. I have used some of the ideas, but I still have not found the system to answer all my needs.

"I would like to see more ideas and learn of more methods that have been found to be workable as to the best way of filing technical information from articles published in HPAC and other magazines; data from manufacturers of equipment used in heating, piping, and air conditioning work; as well as ideas and data from other sources.

"By 'the best way of filing,' I mean the method that takes the least time and trouble, not only to put the data in the right place originally, but to find it when it's wanted.

"I am in a relatively small engineering office, and we are not large enough to have a librarian to take care of this information."—D.A.C.

• *YOU ARE INVITED to contribute a question for publication, or an answer to a published question. Please address your reply to the Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.*

28-Year-Old Koppers Building Pittsburgh, Pa.

Air conditioning this 33-story building was the largest installation ever attempted in the Pittsburgh area.

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1. Fans had to run extremely quietly because of adjacent offices.
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"Chicago" Airfoil Centrifugal Fans met these specifications perfectly. Their efficiency (92%) enabled the consulting engineer to move the required volume of air with much smaller fans and motors. This not only saved valuable floor space, but also saved horsepower. Their quiet operation (65% less noise) prevented tenant complaints.

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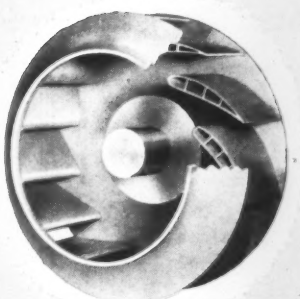

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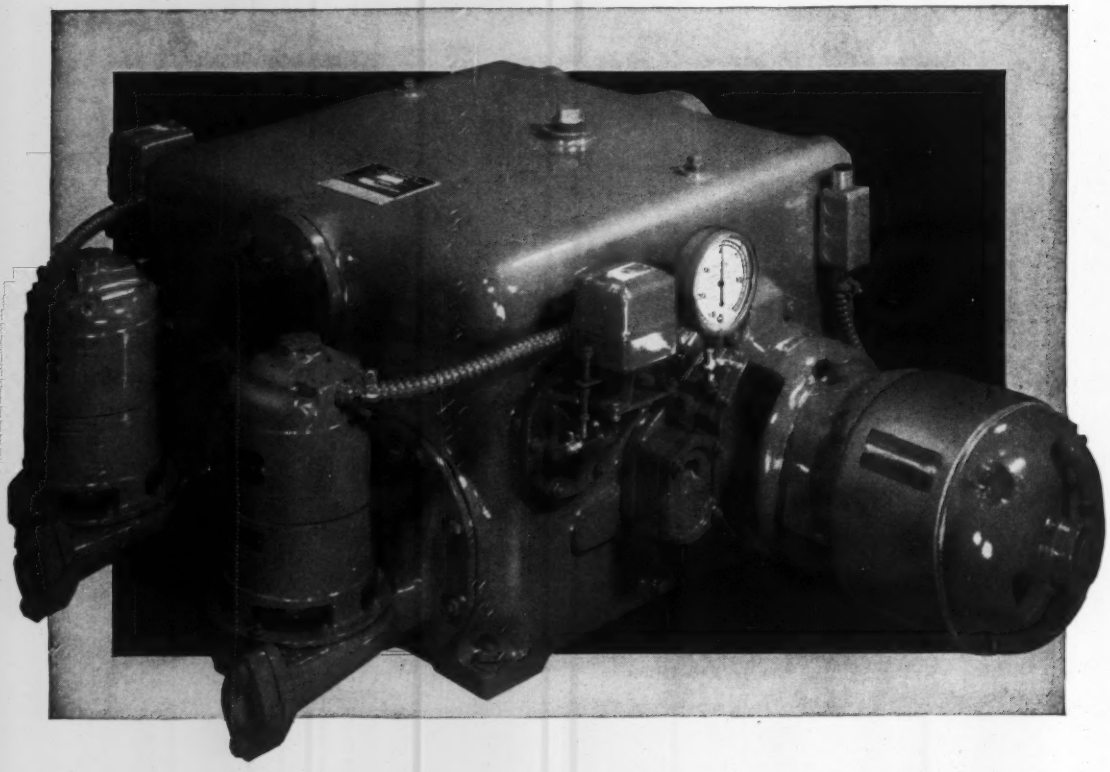

It's the Nash CSM

Designed and manufactured by the organization that made the Jennings Manifold Heating Pump standard of the Heating Industry, the new CSM incorporates every desirable feature architects, engineers, owners and operators have sought. Employing separate air and water pump elements, each with its own motor and each independently controlled by its own automatic switch, the capacities and arrangement may be widely varied to meet job conditions. For the first time, the engineer has the choice of realistic water and air capacities required for rapid system response without wasteful overheating.

These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

- Increased air capacity induces rapid system response without wasteful overheating.
- Separate air and water pumps individually selected to meet actual job requirements.
- Control system that operates individual pumps only when needed.
- Flexibility permitting addition of radiation without changing basic pump installation.
- Low, low, return line connection.

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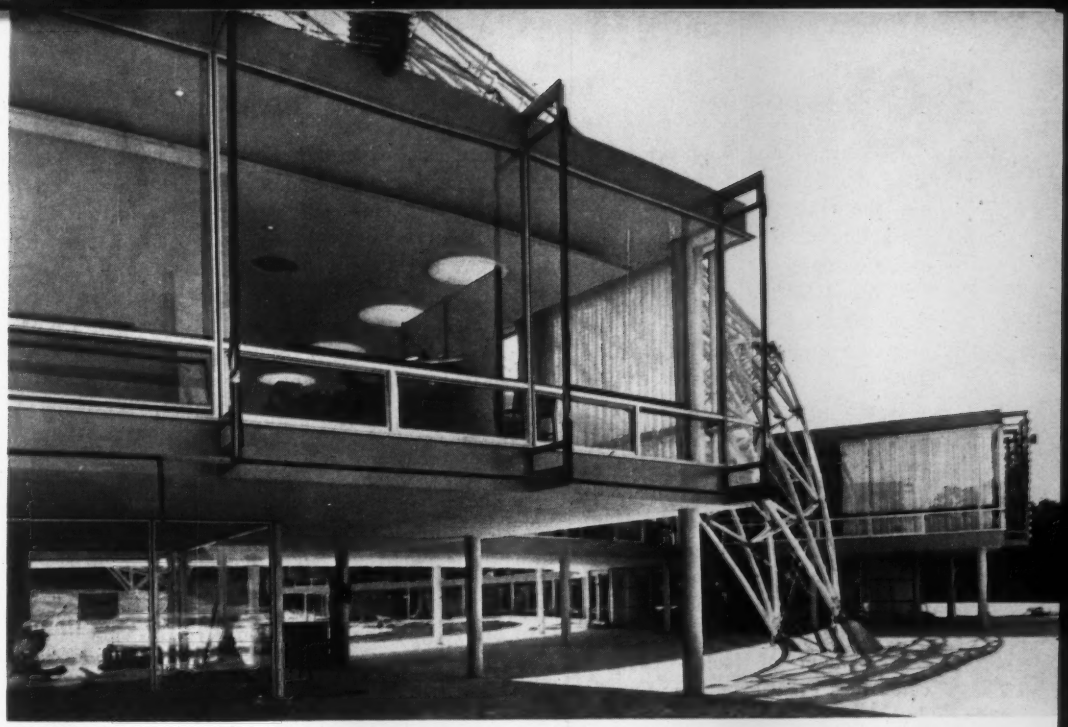
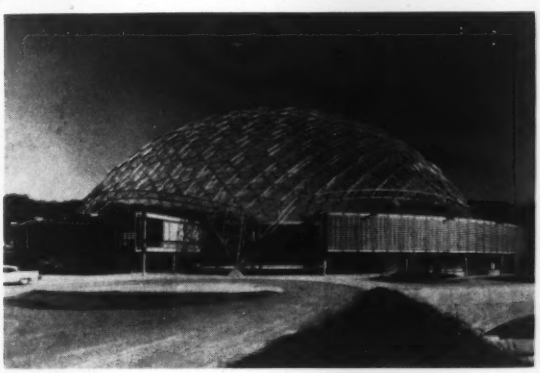


EXPOSED UNDER-PORTIONS of floor slab for this new building's third level necessitated installation of radiant floor panel heating. Other architectural features required applications of wall fin tubing and warm air systems

Heat New, Unusual ASM Building With Three Different Methods

- *wall fin tubing*
- *radiant floor panels*
- *warm air*

BY DAVID NACHMAN
Spohn Heating & Ventilating Co.
Engineers and Contractors



GEODESIC DOME spans new ASM headquarters to enhance structure's aesthetic appeal

BECAUSE of the unusual architecture of the new headquarters office building of the American Society for Metals in Metals Park near Cleveland, three types of heating are used. These systems had to be designed to provide the desired degree of comfort and yet be integrated into the structure.

The three types of heating used are:

1) Wall fin tubing at the large glass curtain wall

2) Radiant floor panels within the floor slab of the second floor to compensate for the heat loss from the exposed underside of the slab

3) Warm air through air handling units and ducts in the ceiling and walls which have been sized for future addition of air conditioning.

Spanned by the world's largest "space lattice," which is 274 ft in diameter and 103 ft high, the building is semicircular, having an arc of 168 deg. The arc itself is 240 ft on its outside face and 140 ft on its inside face, containing a total of 50,000 sq ft of floor area. This area is contained in three levels. Construction is reinforced concrete slabs on exposed steel columns with broad expanses of glass curtain walls.

A number of factors complicated to a great extent the proper design of an adequate heating system. The Cleveland area is subject to extended periods of cold weather, and the consulting engineering firm of Mayer & Valentine and the mechanical contractor, Spohn Heating & Ventilating Co., went to great lengths to assure that the system when installed would heat the building properly, as well as have sufficient response to adapt quickly to changing conditions.

The ASM building has a tremendous amount of glass area for a building of its floor area. A total of 25,000 sq ft of glass area is used, making the ratio of floor area to glass area 2 to 1. For instance, one unbroken window wall is 280 ft long. This made it mandatory that perimeter heating of some sort be incorporated in the system to wipe the windows with warm air.

A second feature of building design that complicated the design of the heating system was the arrangement of the floors. Architect John Terence Kelly conceived the building with its uppermost floor level projecting out from the floor below. In addition, the second level is cut through to provide several passageways, which in turn are bridged by the top, or third, level.

This results in a large floor area of the upper level exposed to outside air, which in turn increases the amount of heat loss through the floor tremendously. This factor made it mandatory that floor panel heating be installed in those portions of the slab of the top floor that were exposed. Some heat loss is eliminated by the application of foam type insulation under the exposed slabs.

A third factor was the desire to provide for future air conditioning by means of circulating air. The fact that the building enjoys a countryside location made it doubtful that air conditioning is essential. Almost every room in the building is located on an outside wall with plenty of natural ventilation. Those portions of the structure exposed to direct sunlight are protected by a special sunshade of stainless steel, 13 ft high and 240 ft long, designed for the building by Mr. Kelly.

When all these factors were considered, it appeared that the only solution was a system that included perimeter convectors, radiant floor panels, and forced warm air.

Heat for the entire system is provided by one boiler rated at 3,800,000 Btu per hr, with a capacity to heat 380 gpm of water continuously from 180 to 200 F. This hot water is piped directly to the finned copper tube at the perimeter and in the fan-driven air handling units. It is also used to heat the water and antifreeze mixture that circulates through the radiant floor panels, by using a heat exchanger. Each component has its own independent pump, operating on an indoor-outdoor temperature control.

Each System Does Specific Job

The complexity of the overall system calls for a separate dis-

WORKMEN are shown installing copper tube for radiant heating system. Continuous lengths of flexible tube were bent to shape, joined, covered with 3 in. concrete topping

cussion of each of its components. While maintenance of a comfortable temperature within the building is a closely coordinated function of all three system components, they each have a specific job to do. None of them could do the complete job by itself, although the perimeter convectors satisfy the bulk of the heating load.

The design of the building is such that no chimney could be provided, as it would destroy the architectural effect, according to Mr. Kelly. It was for this reason that it was necessary to discharge the boiler exhaust gases through an underground tile pipe to a stack 150 ft off in the woods south of the building. An induced draft fan is used on the boiler.

Circulation of hot water is through copper tube of various sizes. Type "L" tube with soldered fittings is used throughout for the distribution system under 2 in. A total of 11,400 ft of copper tube is installed ranging from the 2 in. diameter Type "L" for hot and cold water supply, down to ½ in. Type "L" for the panel heating system. Main supply lines for hot and cold water, larger than 2 in., are black steel pipe.

Convectors Satisfy Big Load

The perimeter convectors satisfy the major heating load for the building. These convectors, consisting of 1¼ in. copper tube with 4¼ in. square aluminum fins spaced 10 to the foot, are located at chair-rail height all along the exterior walls of the building. A special bracket was designed that holds the tube as well as a protective wooden chair-rail that covers it on the room-side face throughout its length.

The hot water for this system is circulated by a separate pump, rated at 150 gpm against a 110 ft head. The system includes a 180 gal expansion tank located in the boiler room.

Control of the system is accomplished in two ways: A master controller located on the outside of the building acts to reset a submaster immersion thermostat located in the supply line to the radiation system. This submaster thermostat modulates a three-way mixing valve and varies the temperature of the circulating hot water in accordance with a predetermined schedule that provides for hotter water circulating as the outside temperature drops. No provisions are incorporated for interior or local control, as this is handled by the multi-zoned air handling units. The entire convector heating system goes off, by shutting off the circulating pump when the exterior temperature reaches 65 F and over.

Radiant Panel Heats Floor

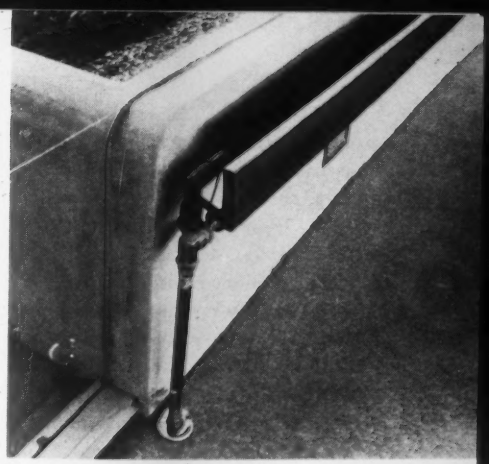
The radiant floor panel heating system is restricted to the upper floor. Basically, it consists of sinuous coils of Type "L" copper tube ½ in. ID, laid in continuous lengths whenever possible. There are a total of 24 separate panels on the second floor, fed from three different risers from the boiler room. The panels range in size from 60 to 200 ft long, with spacing between coils from 24 to 48 in.

The heat outputs of these coils, computed with water circulating at 120 F, range from 10,000 for a panel 200 ft long having a coil spacing of 36 in., down to the low figure of 3000 Btu per hr for two panels measuring 60 ft in length with a 48 in. spacing. Balancing of the system is accomplished through flush floor boxes, each having a balancing valve, an air vent, and a thermometer well.

The copper tube is covered with 3 in. of poured concrete, and was laid and anchored dead level to assure that the concrete layer would be of uniform thickness. This installation procedure assures uniform floor surface temperatures on the floor panels.

The hot water circulating through the radiant panels is heated by means of a U-bend heat exchanger. Hot water from the boiler enters this convertor at 200 F and leaves at 170 F, while the circulating mixture, which contains an ethylene glycol solution, enters at 110 F and is heated to an exit temperature of 130 F. Two pumps operate this system. The pump feeding water from the boiler to the heat exchanger is rated to pump 30 gpm against a 20 ft head. The pump circulating the water to the second floor radiant panels is rated at 35 gpm against a 90 ft head.

Control for this system closely parallels that for the perimeter convectors. An outside thermostat modulates a three-way mixing valve that varies the temperature of the circulating water to the floor panels in accordance with a predetermined schedule. The system is cut out of operation by shutting off the circulating pumps when the outside temperature goes above 60 F.



PERIMETER CONVECTORS, located at chair-rail height all along exterior walls, are protected from damage by this special bracket

Close Air Handling Control

The air handling system is the most closely controlled of the three systems. Being the most responsive, it is used to accommodate itself to the many individual variations in heating requirements for various parts of the building and the special purpose rooms. To

achieve these variations so as to satisfy each particular use of an area, there are 23 separate zones, each individually controlled by thermostatic devices.

Three main multi-zone air handling units serve the building, one for the south wing, a second for the center wing, and a third for the north wing. In addition, a fourth unit is used to heat and ventilate the conference room. The units for the south and center areas are rated at 22,100 cfm, at an entering temperature of 52 F and an exit temperature of 100 F, using 77 gpm of 200 F entering water at a coil face velocity of 1100 fpm. The unit for the north wing is rated at 12,000 cfm, using 42 gpm of 200 F entering water. The conference room unit is rated at 2400 cfm of air, raised from 52 to 90 F by 18 gpm entering at 200 F and leaving at 170 F.

Control of the air handling system is achieved through the use of a two-pipe pneumatic automatic temperature control system. Each multi-zone unit is controlled by a remote bulb thermostat that maintains a fixed mixed air temperature by modulation of the outside air damper, the return air damper, and the relief damper. A master controller in the outside air duct operates to increase or decrease the hot deck temperature, in accordance with the outside temperature, by resetting a submaster thermostat located in the hot deck.

This submaster thermostat controls a three-way mixing valve on the hot deck coil. Freeze-up protection is provided by a low temperature controller which stops the fan and closes the outside air damper when the discharge temperature from units falls below 40 F.

Individual room control is maintained in each zone served by the multizone units by a room thermostat which modulates the mixing dampers for each particular zone.

Circulation of hot water is cut off to all heating coils when the outside air temperature is 70 F. It should be noted that the progression of cut-off temperatures for the various component systems is 60 F for the radiant panel heating, 65 F for the perimeter convectors, and 70 F for the air handling units. Naturally, these temperatures are an indication of the responsiveness of each system, the less responsive ones being cut out of operation first to prevent excessively high room temperatures that may be attributed to the residual heat in the systems.

Control of the air handling unit for the conference room is designed to accommodate the presence of large numbers of people. Because of this, provision for introducing outside air for ventilation is included if the room temperature goes above that called for by the room thermostat.

This room thermostat controls the modulating three-way valve in the hot deck, the outdoor air damper, return air damper, and relief air damper in sequence. When the room temperature is below the thermostat setting, both the outdoor and relief air damper are maintained at their minimum positions and the three-way valve is open to the coil.

As the room temperature increases, the thermostat modulates the three-way valve to its full bypass position. Then, if the room temperature continues to rise, the three-way valve continues to bypass the coil while the outdoor air damper and the relief air damper open to provide natural cooling. These dampers close automatically if the fan stops running. Freeze-up protection is also provided, as with the multi-zone units.

30,000 Lb of Ductwork

Supply and return ducts total 30,000 lb of galvanized duct from 18 to 26 gage, with all possible ductwork concentrated into the service "cores" within the building. The end walls of the toilet corridors are treated as air plenums, as is the ceiling outside the dining room. The circular outside planting box at the entrance serves as a large plenum also. The system delivers 50,000 cfm, and it can handle all outside air or exhaust it all.

The circular brass spinnings or "portholes" in the arc wall of the lobby are warm air outlets, served by 4 in. ducts within the walls. The spinnings on the lower level function in the same way. Similarly, the "eyelashes" pattern of the ornamental copper screens at the main stair, etc., was chosen because the screen can also serve as an intake or supply air outlet.

Specially designed circular air diffusers are set flush with the ceilings on the lower and second floor levels. All diffusers are the same size, with necks varying according to need and location. "Half diffusers" are installed in parts of the second floor ceiling. These can be converted to full round diffusers if partitioning of the general offices is changed.

As this discussion demonstrates, the overall heating system is designed to take advantage of the best points of all three component systems, as well as provide for future cooling by air conditioning.

The building was occupied during the latter part of the summer of 1959. Experience to date has shown that the problems posed by the strikingly unusual architecture have been solved to the satisfaction of the architect, and to those most critical, the engineers and the contractors themselves.

The heating, ventilating, and air conditioning systems were designed by Mayer & Valentine, consulting engineers. The systems were installed by Spohn Heating & Ventilating Co., mechanical contractors. Architect for the building was John Terence Kelly.

Photos courtesy American Society for Metals and Chase Brass & Copper Co.

HOW TEMPERATURE, VELOCITY OF POTABLE WATER AFFECT CORROSION OF COPPER AND ALLOYS

What Is Corrosion?

• For the past quarter century, copper and its alloys have found increasing use as tube for both commercial and domestic water distribution systems. During this same period the use of softened water has increased greatly. Accordingly, with these two concurrent developments, instances of corrosion and corrosion failures have been observed, with an increasing interest in the determination of the basic causes of corrosion and of corrosion mitigation. As an introduction to subsequent articles on the effects of various types of potable waters on copper and its alloys, a review of some types of corrosion and of corrosion theory is presented.

About the authors:

Malvern F. Obrecht, holder of a PhD in chemical engineering from Michigan State University, has a broad industrial background. He is experienced as a full-time research and development engineer, as an advisor to presidents of several midwestern firms, and as an active consulting engineer. A noted authority on water treatment, corrosion, and steam and power, he is member of the Boiler Code Advisory Board for the State of Michigan and is a registered professional engineer. Since 1949 Dr. Obrecht has been an adult extension lecturer on water treatment and power plant operations. Currently, he is engaged in several research projects at Michigan State. A member of numerous technical societies, he is listed in American Men of Science, Who's Who in American Education, and Leaders in American Science.

Laurence L. Quill received his BS and MS in chemistry at the University of Nevada in 1924 and 1925, respectively, and earned his PhD at the University of Illinois in 1928. He stayed at Illinois until 1935 when he moved to Ohio State University as assistant professor of chemistry. In 1939 he was made full professor and, from 1936 to 1942, served as supervisor of the division of general chemistry at OSU. He became head of the department of chemistry at the University of Kentucky in the autumn of 1942 and moved to Michigan State in 1945 as head of the department there. A member of the American Chemical Society since 1922, Dr. Quill has been very active editorially for ACS and is the author of over 50 scientific publications. He is president of the board of directors of the Associated Midwest Universities for 1959-60 and is also a member of the advisory review committee for the division of chemical engineering of Argonne National Laboratory. ▶▶▶

BY MALVERN F. OBRECHT
Water Treatment Consultant
and Professor of Chemical Engineering
and
LAURENCE L. QUILL
Head, Department of Chemistry
Michigan State University

CORROSION of nonferrous metals in aqueous solutions may be due to any one of the following: (1) direct chemical attack, (2) pitting corrosion, (3) galvanic corrosion, (4) stress corrosion, (5) corrosion fatigue, or (6) erosion-corrosion or impingement corrosion.

From these terms it is evident that corrosion and or erosion is a disappearance or "wearing away" of metal by either a chemical or physical action, or a combination of these two. There is no sharp line of distinction among these classes, but the arbitrary classification is helpful in discussions of corrosion. Any corrosion resulting from a chemical reaction is electrochemical since transfer of electrons is involved in the action.

The reactions occurring in any form of chemical corrosion are typical reactions of metals being converted to compounds of the metals. Except for the metals low in the Electromotive Force Series, all metals have a tendency to change into compounds.

The compounds of the metals formed in corrosion may be either relatively soluble or relatively insoluble. If they are relatively insoluble, the product may serve as a protective layer to hinder corrosion, provided the compactness and porosity of the compound are favorable for forming an adherent film on the metal surface. If the compound is soluble, the wearing away of the metal is enhanced. The rates of corrosion depend upon the characteristics of the metal or alloy, the nature of adhering films, the corroding medium, the velocity of flow, the temperature, etc.

● Direct Chemical Attack

Direct corrosion by chemical attack results from direct contact of a corroding medium and a metal or alloy. It is the basic process for preparing compounds of many metals. The corroding medium may be an acidic, alkaline, or salt-containing solution. Metals having a tendency to dissolve readily in such solutions are generally not employed for distribution systems or for equipment where corrosion must be avoided. In direct chemical corrosion, the chemical reaction involves a shifting of electrons directly from the metal to the active corrosive agent.

This is the second of a series of articles, the first of which appeared in the January issue.

● Pitting Corrosion

Pitting corrosion is the result of local cell action which is usually brought about when particles are deposited on a metal surface either as flakes of solid or bubbles of gas. Often, the effect is due to an oxygen concentration cell. The pitting is a localized accelerated attack resulting in cavity or pit formation around which the metal is relatively non-attacked; the pitting is due to anode areas set up by factors such as an oxygen deficiency in an area under a deposit.

Pitting can be a destructive and expensive form of corrosion because of the pin-hole leaks which develop. A good illustration of localized pitting corrosion of a copper tube exposed to steam condensate containing only dissolved oxygen and carbon dioxide is shown in Fig. 1.

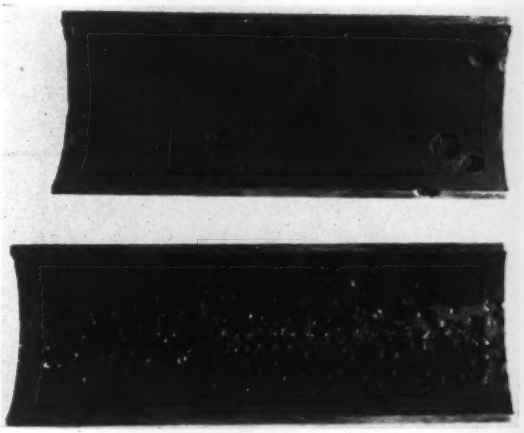
● Galvanic Corrosion

Electrochemical corrosion may also result from a chemical reaction involving the metal or alloy and the corroding medium. It differs from the direct chemical attack in that the electrons move indirectly from the metal to the corroding medium.

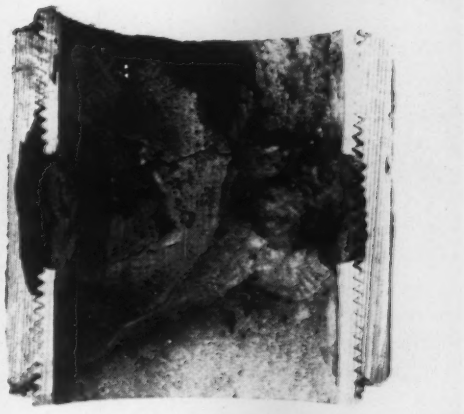
Conditions for galvanic corrosion must be such that there can be a flow of electricity between two areas of metal surface or electrodes through a solution capable of conducting an electric current. These reactions may be thought of as occurring between two electrodes with the solution and the walls completing an electrical circuit. The electrodes may consist of two different kinds of metals, or they may be different areas on the same piece of metal. In either case, there must be a potential difference between the electrodes so that electricity will flow. An example of galvanic corrosion is illustrated in Fig. 2.

At the anode, positively charged atoms of metal detach themselves from the metal surface and enter the solution as ions, while electrons are left in the metal. The electrons travel through the metal to the cathode. At the cathode the electrons reaching the surface through the metal cause reduction of some species, such as hydrogen ions which have migrated through the solution. If the hydrogen ions lose their charge and become neutral atoms again, they may combine to form hydrogen gas. Water molecules may also be reduced directly. The release of hydrogen ions results in a build-up of hydroxyl ions.

Reduction of oxygen dissolved in the solution can occur to complete the cathode reaction. Any cathodic reduction will permit corrosion to proceed. Thus, the cathodic reactions can involve either hydrogen evolution, reaction with oxygen, or reaction with some



1 PITTING of copper steam condensate pipe after 15 years' service. Deposit is cupric oxide mixed with magnetic iron oxide



2 GALVANIC CORROSION is evidenced in this 2 in. brass pipe connected by steel coupling. Deposit is iron rust

other reducible substance.

Reactions that proceed with the liberation of energy in the form of useful work are called spontaneous reactions. Oxidation-reduction reactions are reactions in which electrons are transferred from the substance being oxidized to the substance being reduced. Spontaneous oxidation-reduction reactions are therefore reactions in which a liberation of useful energy can accompany the electron transfer. This liberated work can appear as electrical energy.

If a cell is set up and the cell reaction is allowed to proceed very slowly, one is able to obtain practically all of the energy liberated in the reaction as electrical energy in an external circuit. The energy liberated will be the electrical energy produced; it will be equal to the product of volts, amperes, and time. From Faraday's Law, the amount of electricity produced when a reaction occurs between gram equivalents of reducing and oxidizing substances is the same in all cells. Thus, the differences in energy liberated in the various cell reactions are simply related to differences in cell voltages. If Q represents the energy liberated when gram equivalents react, E represents the cell voltage, and F denotes the Faraday, the following equation indicates when the cell is discharged under such conditions that all of the available energy liberated in the reaction is converted into electrical energy:

$$q = FE \quad \text{.....[1]}$$

When a cell is discharged under conditions such as to obtain the maximum available energy as electrical energy, the cell is said to be reversible, and E under these conditions is called the reversible electromotive force of the cell. It can then be seen that E (reversible) is a measure of the driving force that makes the reaction proceed.

All oxidation-reduction reactions may be divided into two half-electrode reactions. One reaction is an oxidation; the other, a reduction. Similarly, the total energy liberated in the reaction may be divided between the two half-reactions. The total energy can be written as the sum of the two half reactions:

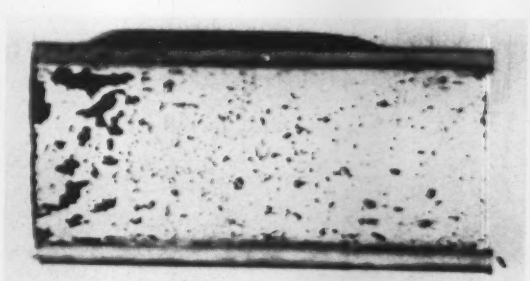
$$q = q_a + q_b \quad \text{.....[2]}$$

From Equation 1 it can be seen that the following is true:

$$E_t = E_a + E_b \quad \text{.....[3]}$$

If the total cell voltage can then be measured, and if the potential of one of the half-reactions is known,

3 OXYGEN CONCENTRATION CELL (pitting) of copper tube is shown above



4 UNIFORM DEZINCIFICATION has occurred to this section of brass tube. See Fig. 5

then the potential of the other half-reaction can be calculated from Equation 3.

Measurement of the potential of one of the half-cells would be impossible to accomplish, but this problem has been bypassed by arbitrarily assigning an electrode potential of zero to the standard hydrogen electrode. This consists of a platinum electrode covered with platinum black whose surface is kept saturated with hydrogen gas at a pressure of one atmosphere.

The cell potential of any cell can be measured relative to the hydrogen electrode. The potentials have been measured for a great number of electrode reactions and are available in tables of standard oxidation potentials. If the electrode is set up so that it loses electrons, the e.m.f. is called the standard oxidation potential; if it gains electrons, then the potential is called the standard reduction potential. The standard oxidation potential and standard reduction potential are equal numerically but opposite in sign. The more positive the standard oxidation potential, the greater is the tendency for the electrode to lose electrons.

Combination of two single electrode reactions, one in the direction of oxidation and the other in the direction of reduction, makes a complete oxidation-reduction reaction. If the algebraic sum of the standard oxidation potentials is positive, the reaction will proceed spontaneously. If it is negative, the proposed reaction will not go spontaneously, and electrical energy would be needed from an outside source to make the reaction proceed.

Two Common Oxidation States

Copper has two common oxidation states: positive one (cuprous) and positive two (cupric). A third state, positive three, is encountered in a few unstable compounds.

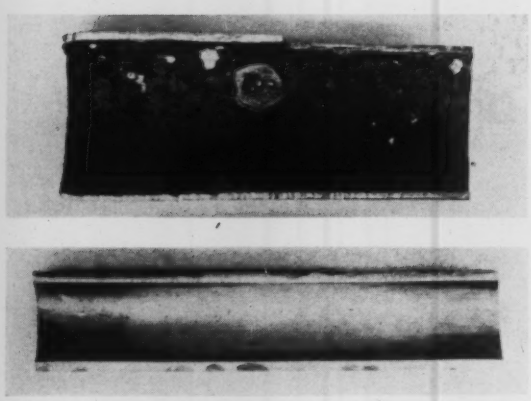
Most of the simple cuprous compounds are insoluble in water. Those which are simple and soluble are unstable and in equilibrium with metallic copper and the cupric ion. Many of the cuprous compounds (sulfide, halides, oxides) are so insoluble that the concentration of cuprous ions in solution never reaches the very low limit indicated by the equilibrium constant. In contrast to the simple salts, cuprous copper forms many stable complex ions, where the equilibriums favor the cuprous state.

Whereas the cuprous ion is colorless and diamagnetic, the cupric ion is paramagnetic and is strongly colored (presence of incomplete group of 17 electrons). The cupric salts are usually more soluble than the corresponding cuprous compounds.

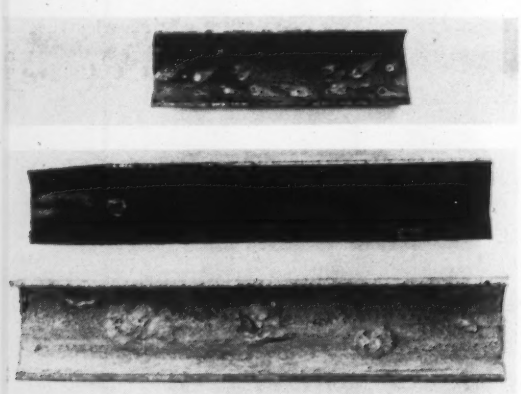
Corrosion processes, like all other processes involving chemical reactions, are subject to thermodynamic treatment. Corrosion reactions are generally somewhat more complicated than ordinary reactions. The liquid phase may contain several ionic species and dissolved gases. In addition to the metal and water solution, a third phase as a surface film consisting of pure or mixed metallic salts is usually present.

While complete thermodynamic treatment of such a system is difficult, much valuable information can be obtained by considering a simplified system. For example, consider a system of copper immersed in pure, degassed water. The only films capable of forming would be oxides or hydroxides of cupric or cuprous copper. In such a neutral system, the hydroxide and hydrogen ion concentrations are fixed. The reduction of hydrogen ions or of water to form hydrogen gas is the only possible half reaction to combine with the oxidation half reaction of copper. Using standard oxidation potentials, the overall reaction for the system can be shown to have a negative potential; thus the reaction will not proceed spontaneously.

A system consisting of copper and pure water, if



5 DEZINCIFICATION can occur locally, as well as overall. See Fig. 4 on preceding page



6 EXAMPLES of corrosion occurring under non-uniform film deposits shown here

open to the atmosphere, would contain dissolved oxygen. At room temperatures the oxygen concentration could be about 8 ppm. This concentration of oxygen enhances the possibility of corrosion taking place, with the dissolved oxygen acting as the oxidizing agent. For the reactions involving copper being oxidized to cuprous ion and oxygen being reduced to oxide, the potential is positive and the reaction occurs.

Calculations of the cell potential are refined by considering the concentrations of the ionic species present in the system. The maximum concentration of cuprous ion is limited by the solubility product relationship for cuprous hydroxide. In a neutral system the maximum solubility of cuprous ion is 1×10^{-7} equivalents per liter. If that value is exceeded, then cuprous hydroxide will form as a third phase or precipitate. The activity of the oxygen in the system is equal to its activity in the atmosphere and is approximately equal to 0.20 of an atmosphere.

Using the Nernst Equation, and knowing the concentrations of the various species present, the actual cell potential can be calculated and has been found to be 0.666 volts. It is possible that the precipitate could form on the metal surface to act as a protective film and limit the extent of the reaction. However, if a supply of oxygen is continually present, the reaction will continue slowly until all of the copper is corroded. A good illustration of the failure of a copper tube due to an oxygen concentration cell (pitting) is shown in Fig. 3.

In the foregoing example, copper was considered as being oxidized to the cuprous state, as would be expected from thermodynamics. Similar calculations for copper changing to the cupric state give values not too greatly different from those of the change to the cuprous state. There is some evidence that the cuprous compound is formed at first and further oxidized to the cupric state when sufficient oxygen is present.

Although the system chosen as an example is a simple one, the results are helpful in analyzing actual systems. The most important point is that corrosion of copper by aqueous solutions must be the result of oxidation by dissolved oxygen although the presence of other reducible substances must not be overlooked.

The galvanic cell or couple potentials which have been discussed so far have been reversible potentials; i.e., potentials where all of the potential or free energy liberated in the reaction is converted into electrical energy. All processes for the conversion of energy of one form or another become less efficient as the speed of the conversion is increased. This behavior is also true of the galvanic cell. If current is taken from the cell at a rapid rate, only a fraction of the energy liberated will be converted into electrical energy. Thus the voltage of the cell is lowered. The difference between the reversible voltage and the actual voltage is called polarization; it is also sometimes known as back- or counter-electromotive force.

It is convenient to classify the various polarization effects as follows:

1) Voltage drop due to the resistance of the electrolyte between the anode and cathode areas. This is equal to the current flowing times the electrical resistance of the solution.

2) Voltage drop due to the resistance of the external circuit between the anode and cathode. This is also equal to the current flowing times the electrical resistance of the circuit. In corrosion, it is usually very small because the corrosion couple is essentially a short circuited cell, the resistance of the metal being very small.

3) Polarization at the anode. The total anodic polarization is the sum of (a) concentration polarization at the anode, (b) anodic overvoltage due to some slow process in the overall anodic reaction, and (c) the resistance of films that cover the anode surface.

4) Polarization at the cathode. The total cathodic polarization is the sum of (a) concentration polarization at the cathode, (b) cathodic overvoltage due to same slow step in the overall cathode reaction, and (c) the resistance of films on the cathode surface.

Concentrations Determine Potential

The concentrations of substances at the electrode surface are those which determine the potential of an electrode. As the reaction proceeds, the concentrations in the vicinity of the electrode will be different from those in the main body of the electrolyte. The concentration gradients which are set up when a cell discharges at a high rate cause a back electromotive force and is called concentration polarization.

Overvoltage Is Affected by Several Factors

It has been found that, after the possibility of concentration polarization is eliminated, a polarization effect is still noticeable in many reactions. Overvoltage is nothing more than the polarization of a cell which cannot be attributed to concentration polarization or film resistance. In general, reactions which involve gases have overvoltage of considerable magnitude. Factors which affect overvoltage are:

1) Current density. Overvoltage increases with current density, finally reaching a maximum at high current densities.

2) Temperature. Overvoltage decreases with an increase in the temperature.

3) Smoothness of the metal surfaces. Overvoltages are lower on rough surfaces; they are a surface area effect.

4) Composition of the electrode. Platinum, silver, and gold have low overvoltages. Catalytic effects may be involved in some electrode reactions. Since some of the reactions are rapid and some slow, the overall effect is governed by the slowest reaction of the sequence.

Films Will Increase Polarization

Films on either the anodic or cathodic areas will increase the polarization for two principal reasons: (1) they cause an increase in the resistance of the path between the anode and cathode, and (2) they decrease the rate of diffusion of reactants and products of the electrode reactions toward and away from the electrode surfaces, thus increasing concentration polarization to a much higher value than would prevail in the absence of these films.

Many Items Affect Electrochemical Corrosion

Thermodynamic relationships can be used to set the limits on corrosion systems, but these relationships provide very little information about the kinetics of the reaction or the rates involved in the overall process. Therefore a discussion of some of the factors which influence the rate and type of galvanic corrosion is necessary for a better understanding of some of the mechanisms involved.

The first of these factors, but not necessarily the most important, is temperature. Temperature is an important variable in all chemical reactions, including corrosion reactions. Increases in temperature are characterized by increases in ionization, diffusion rates, and electrical conductivities and by decreases in gas content of the solutions involved. Any one of these changes could help to accelerate corrosion reactions. However, the effect of temperature varies with the character of the circulating medium and the nature of the tube alloy involved.

The velocity of the solution in contact with copper tube affects the rate of corrosion considerably. Some mechanisms by which the corrosion rate is affected are secondary, such as lowering the tube temperatures, the character of corrosion products formed, and the change in volume of mechanically entrained gas contacting the metal. However at velocities where turbulence is present, erosion-corrosion is a direct result of the velocity of the solution. Turbulence is also very often responsible for the formation of local cells at the tube surfaces which cause severe local pitting.

Corrosion reactions depend on the nature and properties of the corroding medium. In this particular study the medium used is water. Factors that are important in determining the aggressiveness of water are: (1) oxygen concentration, (2) hydrogen and hydroxide ion concentrations, and (3) dissolved salt concentrations.

Effect of Temperature

As previously mentioned, addition of heat energy to a chemical reaction generally accelerates the reaction. Different reactions are affected differently and there are no simple rules which accurately define the effect of temperature. Qualitatively, an increase in temperature of 18 F in a corroding solution could easily increase the speed of the reaction by a factor of two. Obviously then, under actual service conditions, slight increases in operating temperatures could accelerate corrosion enough to be a major factor in short tube life.

Increases in temperature of certain waters may actually slow down corrosion reactions by decreasing gas concentrations in the water and by encouraging the formation of a thin, continuous, protective coating on the tube walls. This mechanism of scale formation with temperature increase is demonstrated by the decomposition of calcium bicarbonate at elevated temperatures to calcium carbonate scale, water, and carbon dioxide gas:

$$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$$

If a continuous film is formed, the tube metal may be protected. But if breaks occur, pitting is likely to take place on the exposed areas, especially when the water velocity is high.

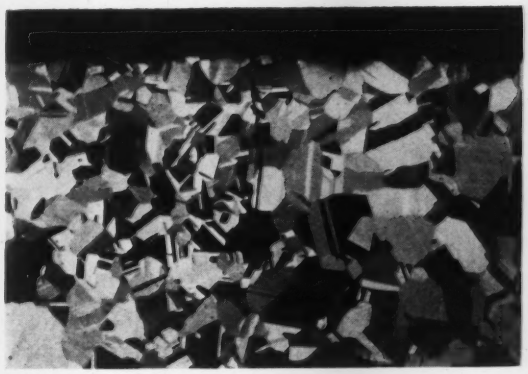
When dealing with condenser and heat exchanger tubes, local overheating of the tubes will cause severe local corrosion and pitting. The main cause of local overheating is low water velocities.

Severe local pitting can occur on local hot spots on the cooling water side when bubbles of gas separate from the water. There is a definite tendency for the bubbles of gas to continually form on the same local tube surface. The bubbles grow rapidly at first and then adhere to the metal surface for some time. The operating life of these tubes can be extended by preventing gases from adhering to the tube walls. Increasing the cooling water velocity will have the twofold effect of lowering the temperature and sweeping the tube surface free of gas bubbles.

This type of local pitting in the copper-brass alloy can be identified by the formation of nodules of cupric oxide (CuO is characterized by a black or greenish black color) over deep pits which are usually filled with bright red, crystalline cuprous oxide.

Another type of local pitting is dezincification in which both copper and zinc are dissolved with a subsequent redeposition of copper as a red porous mass. Dezincification may be of two forms: uniform across the entire surface (Fig. 4) or localized or plug type (Fig. 5).

7 STRESS CORROSION cracking in arsenical admiralty copper after 11 years' service in air removal section of surface condenser



8 TRANSGRANULAR CRACKING due to stress corrosion of a brass tube is shown above

Oxygen Concentration Has These Effects

The rate of corrosion of most metals and alloys immersed in water is, in most cases, directly dependent upon the rate at which an oxidizing agent can reach the metal surface. In a great majority of cases, the rate of corrosion is almost directly proportional to the concentration of oxygen in the water. The oxygen in the water liberated at elevated temperature does not take part in the cathodic reaction — only the dissolved oxygen is an active agent. Decrease of dissolved oxygen with increase in temperature is a factor which decreases the corrosion rate.

Oxygen does not combine with absorbed hydrogen atoms, because, in the case of copper and its alloys, hydrogen ions are not reduced at the cathode. The cathodic reaction is the transfer of electrons from the metal to dissolved oxygen.

Hydrogen Ion Concentration Has Many Effects

Solutions which are acidic in character are usually more corrosive toward metals than neutral or alkaline solutions. Minimum corrosion does not necessarily occur with neutral solutions. However, for metals which are amphoteric (aluminum, tin, lead), corrosion may be very rapid by alkaline media.

The pH value of a solution does not necessarily indicate the corrosiveness of a solution. Two solutions with identical pH values may differ widely in their action on metals, depending on the actual compound influencing the pH value and on the concentrations of other salts, gases, etc., in the solution. With very few exceptions, the presence of oxygen increases the severity of corrosion.

However, while no definite predictions can be made of the behavior of metals in solutions of a given pH value, this information regarding the degree of acidity or alkalinity is valuable, when considered with other factors, in order to correctly interpret corrosion problems.

Composition of Solution

Other substances found in water may have very definite effects on corrosion rates. Gases such as carbon dioxide or hydrogen sulfide are acids — their acidic behavior is amplified when they are dissolved in water. This enhanced acidity may affect the corrosion rate by producing unstable film conditions (Langelier Index) or, in the absence of sufficient mineral content, may cause dissolution of the metal by direct chemical attack.

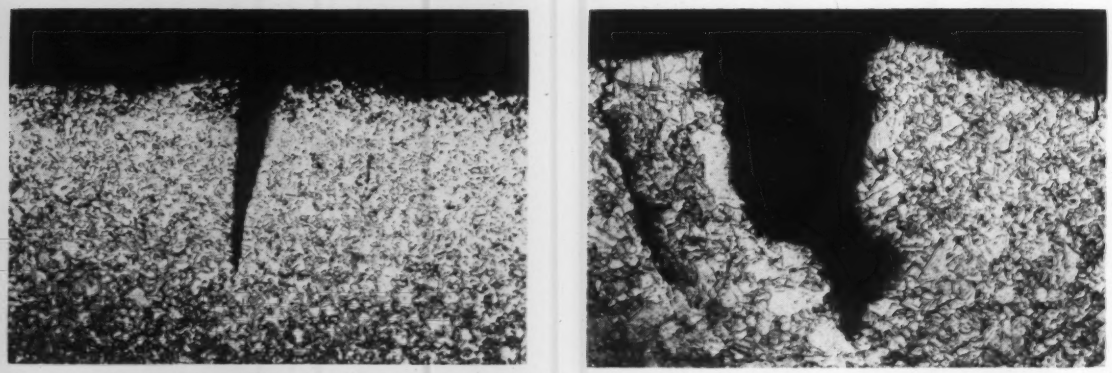
Potable waters frequently contain substantial amounts of carbon dioxide. Dissolved carbon dioxide results in aqueous carbonic acid which, like any other acid, has the effect of accelerating corrosion.

Hydrogen sulfide and other active sulfur compounds are found in peaty soils, sewage, and mineral waters. Even when present in relatively small amounts, hydrogen sulfide is a very active corroding agent.

The presence of oxygen in water with either of these two active chemicals tends to increase greatly the potential corrosion problem.

Salts in solution may retard or increase corrosion depending upon the concentration, composition, conductivity, solubility, and many other factors. For instance, certain waters when heated deposit a thick salt layer on the metal surfaces with which the water comes into contact. In these deposits, the most common salt is usually calcium carbonate, but the chemical composition may vary considerably.

Frequently, salt deposits tend to inhibit corrosion by protecting the metal surfaces. But substances like carbon dioxide and hydrogen sulfide in water cause the formation of deposits which actually promote the formation of concentration cells and intense local pitting. Examples of corrosion occurring under nonuniform film deposits are pictured in Fig. 6.



9-10 CORROSION FATIGUE CRACKING, magnified above, is usually caused by vibration of tubes in corrosive environment. While vibration and corrosion are both, of themselves, destructive, combined effect of both is generally worse than either factor alone

● Stress Corrosion and Corrosion Fatigue

Cracking of copper or copper alloy tubes may result from either stress corrosion or corrosion fatigue. For each of these types of corrosive failure, certain differences involving causes and effects and resulting treatment are observed.

In stress corrosion for a given alloy system, two factors are necessary: a stress and a corrosion agent. The stress must be sufficiently high to exceed a certain minimum value for a given corroding medium. The corrosive agent must be concentrated enough to be active at the susceptible area under stress. The primary corrosive agents are ammonia and related compounds which may develop from decomposed organic materials. Examples of stress corrosion (transgranular cracking) are shown in Figs. 7 and 8.

Corrosion fatigue generally results from vibration of a tube in a corrosive environment. Fatigue cracks are sharp, brittle, bright, and crystalline in appearance. The main fracture is usually accompanied by many very minute cracks. The combined effect of vibration and corrosion is generally more destructive than either factor alone. Two examples of corrosion fatigue cracking are illustrated in Figs. 9 and 10.

● Erosion-Corrosion, Impingement Corrosion

Erosion is normally thought of as a destructive process involving the wearing away of a surface. Erosion-corrosion is usually characterized by rapid and repeated destruction of protective surface films in the presence of a rapidly moving liquid. In most cases, action of this type occurs at or near the inlet end of the tubes. The destruction of protective films at such localized areas is due to a relatively high velocity of the fluid medium, together with a turbulent condition and the action of mechanically entrained air. The attack is one of combined erosion-corrosion; erosion removing the scale or protective film and subsequent corrosion of the exposed metal surfaces.

Major factors affecting the rate of erosion-corrosion are the velocity, temperature, and composition of the water solution being passed through a distribution system. The impingement type of corrosion is often associated with entrained gases and high velocities. Several illustrations of erosion-corrosion are presented in the January issue on pages 165-170.

The different types of corrosion and erosion-corrosion concerned with the wearing away of copper and its alloys in water distribution and condenser systems have been outlined. In these corrosive changes, cell actions are involved which may be defined as (1) the metal-metal oxide cell, (2) the solution concentration cell, and (3) the oxygen concentration cell.

In impingement corrosion, when the water impinges on a metal surface, the bare metal is anodic to the surrounding oxide covered surface. Essentially there is a small anode area surrounded by a large cathodic area. The flow of current is concentrated toward the anode with increased anodic oxidation or corrosion of the anode area. The impinging water rapidly removes the copper ions formed by the anodic oxidation, thus causing the bare metal surface to be more anodic than it would be under stagnant conditions. The flowing water also increases the rate of diffusion of dissolved oxygen to the metal surface, causing it to be cathodic with respect to any surrounding area toward which the oxygen is moving less rapidly. With more noble metal such as copper the metal ion concentration cell potential becomes greater than the reduction of oxygen concentration cell potential with the net results that the exposed metal becomes more anodic under impinging water flow conditions.

In the remaining articles in this series, research results of the effects of temperature, velocity, and water composition under simulated service conditions on the corrosion of copper and copper alloy tubes will be presented. These reports will also include design of field test, control monitoring, and research test panels. ≠

Air Cooled Condenser Applications No Longer Limited to Small Sizes

BY WARREN VIESSMAN
Mechanical Engineering Consultant
Hq, Air Research & Development Command
Andrews Air Force Base

NOT TOO MANY years ago, it was common to find statements in leading technical references to the effect that air cooled condensers were seldom used for capacities above three tons unless an adequate water supply was difficult to obtain. Just five years ago, air cooled condenser installations at Patrick Air Force Base, near Cape Canaveral, were limited to 40 tons.

Today, the largest single installation is perhaps one of over 500 tons in northern Africa. Currently, one manufacturer's catalog indicates sizes up to 580 tons. Since large capacities are usually obtained by assembling standard 20 or 40 ton increments, almost any size could be listed by increment or building block procedure.

Practical size limitation is one of economics. Especially in the larger sizes, study should be made of comparative installation, operation, and maintenance costs. Procedures similar to those outlined in Chapter 54 of the 1959 Guide should be followed, to set up comparative costs on suitable condensing equipment such as cooling towers, evaporative condensers, and air cooled condensers.

Size limitations might also be imposed by space available on the roof or ground for the air cooled condensers. Usually, this is not the case.

The capacity of air cooled condensers has not yet been standardized by the industry. A basic capacity rating used by some manufacturers is 90 F entering air, 120 F condensing temperature, and 40 F evaporating temperature.

Size and capacity have no direct relationship, but depend on operating conditions. For instance, a condenser rated at 474,000 Btu per hr at the above basic conditions would have an increased capacity of 33 percent, or 630,000 Btu per hr at 70 F entering air temperature, other conditions remaining the same. Conversely, at 100 F entering air temperature, its capacity would be reduced to one-third, or 158,000 Btu per hr.

Some important economic considerations that affect application and practical size limitations are:

1) The effect of condensing pressure on compressor cost, capacity, and horsepower. For example, for 100 F entering air temperature, a compressor would have only 93 percent capacity, but would require 106 percent electrical input as compared with conditions at 90 F.

2) The length of the refrigerant circuit as it affects compressor head pressure, capacity, and horsepower. Practical distance between compressor and condenser may be 50 ft in some cases and 100 ft in others.

3) Suitable head pressure control to permit satisfactory operation at outside temperatures below 60 F.

4) Air temperature. It is seldom necessary to design for an air temperature above 100 F. A practical limitation for comparative considerations would probably be around 110 F. The higher the entering air temperature, the higher the cost of the condenser or compressor or both. If the head pressure is high, compressor capacity and horsepower would be affected.

5) Life of the equipment and amortization cost are affected by environment. It is standard practice to manufacture air cooled condensers with copper coils having aluminum fins and aluminum, steel, or galvanized steel casings. If the condenser is located in a coastal area where it is subjected to salt particulate matter (solid or liquid), the life of the equipment may be as short as two years, as compared to 10 or 20 for other locations. For such locations it is advisable to have a copper fin and coil design insulated from other dissimilar metallic structural members. The latter would also require protective coatings. Such special constructions are available at an increased cost of about 15 percent.

In many cases air cooled condensers are justified because of favorable maintenance considerations — even in cases of higher investment and operation cost. Where no water is available, the air cooled condenser has no competition.

To further the application of air cooled condensers, more information should be published on the desirability and use of head pressure control and the comparative performance, advantages, and disadvantages of various types of control, such as damper, fan and gas bypass. Also, with the advent of the vertical discharge condensers, information should be made available on the noise characteristics of the several types.

Manufacturers' recommendations for head pressure control piping, when outside the unit, should be made as clear as possible in order to avoid faulty pipe runs by the mechanical contractor making the installation. The manufacturer should clearly indicate desirable or permissible receiver locations with respect to the condenser when these are separate units. ∓

Flexible Connectors Cut Installation Costs of Tall Building Heating

• Flexible metal pipe connectors are the answer to an inherent problem faced by designers of baseboard and finned pipe steam and hot water heating systems for tall buildings: that of how to make connections to the risers in the tight space available and still allow for expansion. And the cost is not as prohibitive as you may think. True, flexible connectors cost more than nipples and elbows. But on the big job, where many connections must be made, savings in time and labor will often result in a lower overall installation cost. Lewis Smith discusses how these cost savings are effected and describes a few of the many ways these connectors can be used.

Mr. Smith, a frequent contributor to Heating, Piping & Air Conditioning, has had many years' experience in heating and air conditioning large buildings. He is responsible for the development of heating systems which are in use in many apartment house projects.

BY LEWIS SMITH
Heating Engineer

THE CURRENT VOGUE for baseboard and various forms of finned pipe as heating surface in multistory buildings has introduced several new problems. One of the most important of these is how to make the connections to the risers in the limited space available and yet provide for expansion. Flexible metal pipe connectors offer an excellent solution.

These connectors, on the market for years for absorbing vibration of pumps and compressors and for many other uses, have only recently been considered as a means for taking up pipe expansion. The reason for this delay has been largely their cost compared with nipples and elbows.

However, in view of the rising cost of pipefitter labor and the lowering of the cost of manufacturing these connectors in large quantities, the stage has now been set where they may be less expensive in final installed cost — a point not yet properly appreciated by many heating, piping, and air conditioning contractors, primarily because of their lack of experience in using them.

Aside from cost, these connectors often solve the space problem for both consulting engineer and contractor in a manner impossible by other means. Finally, it is obvious that, even with no cost advantage, the hours of installation labor are substantially reduced which means that more jobs can be done by the same crew.

Flexible metal connectors are made of lengths of bronze tubing formed into a series of convolutions which provide the necessary flexibility. They are not expansion joints in the sense of being able to absorb lateral movement of expansion and contraction. Although they can handle a slight amount of such motion, they are primarily used for connecting two pipes at right angles to each other. When so installed, the vertical pipe (the riser) can move up and down, bending the connector without straining the other pipe or putting any strain on the copper or steel convector element or finned pipe or the traps and valves which may be used with them.

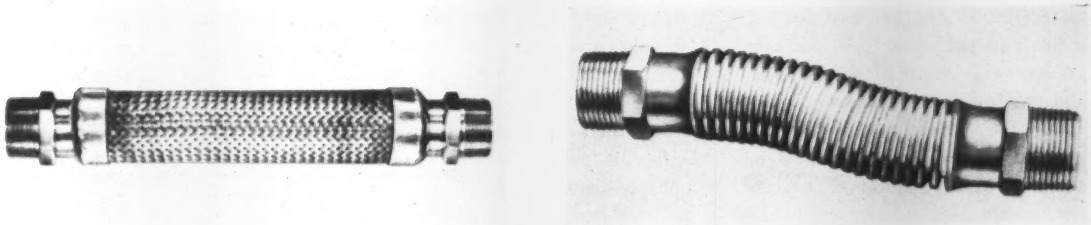
The amount of movement permitted depends on the length and diameter of the connector and is stated in inches of offset on either side of the center line. This permissible movement varies from ½ in. to 1¼ in. or 1½ in. and more for standard lengths and sizes commercially available.

Of course, special lengths can be made to order for practically any condition, but it is the standard product which is of primary interest to engineers and contractors — and especially to the manufacturer, since his costs can be still further reduced through mass production.

If the connector is installed cold with the maximum offset, then the total movement of the riser in the opposite direction can be twice the offset, or 1 to 3 in., for example, which would accommodate any conceivable condition in a heating or cooling system.

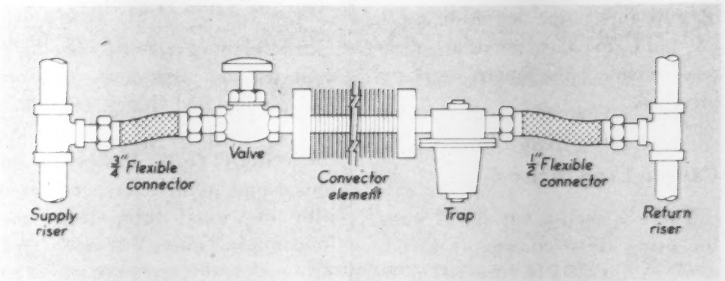
Flexible connectors are made in two types: braided, as illustrated in Fig. 1, and unbraided, as in Fig. 2.

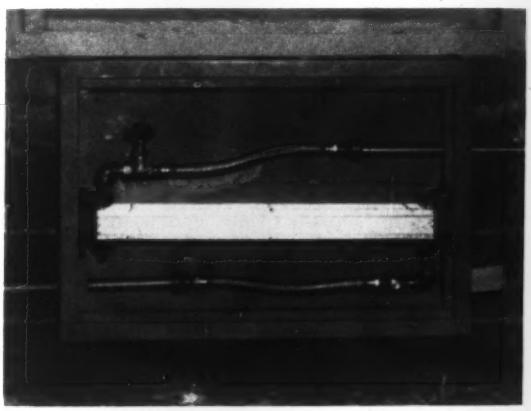
The braid is used for two purposes: (1) to keep the connector from deforming under pressure and (2) to protect it from physical damage while it is being installed. While the maximum working pressure can be clearly marked on the connector, not all manufacturers are willing to make these available without the braid for fear that some contractor will inadvertently use them for jobs where the pressure is in excess of the maximum. Naturally, the braided type costs



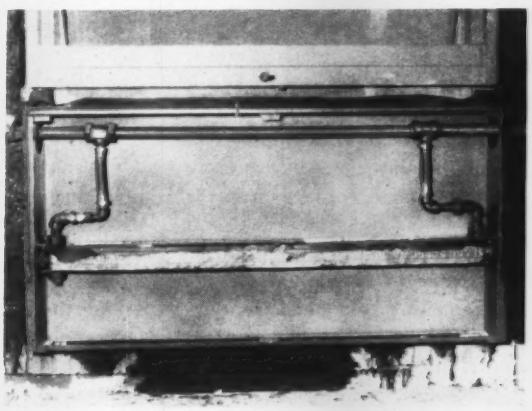
1-2 FLEXIBLE CONNECTORS are made in two basic types: braided (left), unbraided (right)

3 BASEBOARD or finned pipe installation for steam can be made as shown at right. Hot water installation would be same, using balancing fitting in place of trap



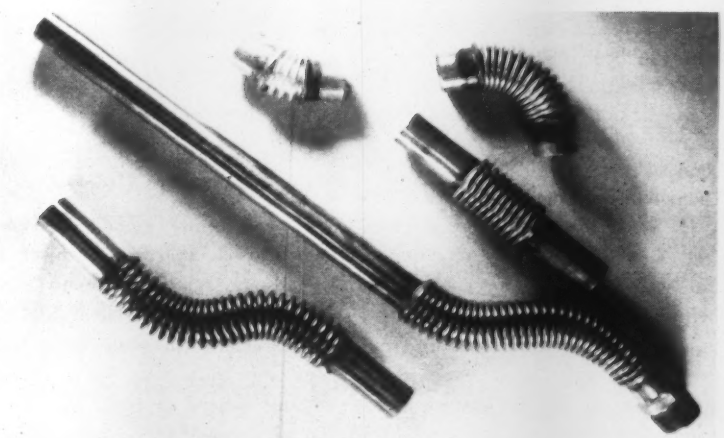


4 CONNECTORS can be used not only to absorb riser expansion but to keep piping snug against walls, eliminating need for furring out walls



5 WHEN CONVECTORS are connected in series in long horizontal mains in hot water heating systems, flexible connectors will absorb expansion

6 WHEN REQUIRED, flexible connectors can be made up with various lengths of nipples



more. But it can be used for all steam and hot water jobs for any pressure encountered in heating and cooling installations.

On the other hand, the unbraided type can also be used in all sizes for all ordinary low pressure steam systems and up to the 1½ in. size on all hot or chilled water systems until the static head reaches that of a six-story building. At this point, attention must be paid to the manufacturer's recommended maximum working pressure.

Can Be Used Many Ways

There is such a variety of ways for using these connectors to advantage that it is impossible to illustrate more than a few of them.

Take the case of a typical baseboard or finned pipe installation, as shown in Fig. 3 for steam (hot water would be the same, using a balancing fitting in place of a trap): Notice how the piping can lie snug against the wall. No extra room is needed for expansion or swing connections at each end which in some cases would make it necessary to hang the runouts on the ceiling below and come up through the floor with the radiator connections.

Expansion is fully taken care of without consuming valuable space or furring out the walls or around columns. Obviously, this job can be done much faster with these connectors. If this were in a 10-story building with 30 radiators per floor, the total time saved for 300 settings would be quite an item, helping the contractor to move on to the next job much sooner than would be possible when using nipples and elbows.

Or take the case pictured in Fig. 4. Note how the piping hugs the wall and can be concealed behind the plaster without furring out the wall. Accurate roughing-in is unnecessary and expansion strains on the copper heating elements are avoided.

Fig. 5 shows how the consulting engineer was able to plan for connecting as many as eight convectors in series on 70 ft horizontal runs between risers. Note how the flexible connectors take care of the expansion of this pipe and how small irregularities in roughing-in are easily handled.

"In Less Than Half the Time"

Several contractors who have used flexible connectors on large jobs have stated that it takes less than half the time to make up the connections from baseboard or finned pipe to the risers, compared with the usual three-elbow and four-nipple "hinge" at each end. Any estimator can easily make up his own cost information, assuming of course that there is space to install "hinges" and that he doesn't have to work through the floor from the ceiling below. By thus speeding up the work, a contractor can do more jobs per month.

Consulting engineers are even more inclined than contractors to make use of flexible connectors because they are seeing ways to simplify the piping and avoid asking the architect for furred-out walls and columns or hung ceilings. This item is paid for by the owners in the general contract rather than in the heating contract.

Even if connectors saved nothing for the heating contractor, they might, in these other respects, save a good deal of money to the owner. This has been proved to be true on several jobs where the total owners' cost has been properly analyzed.

Noisy Convectors Quieted

In a recently completed two-story garden apartment project a single pipe hot water main was used, running down each side of the basement. In some cases the runs were quite long, up to 70 ft, without a bend or turn. The contractor was told to keep the mains snug against the ceiling and close to the foundation wall because the owner did not want piping along the ceiling. This meant very short connections to the convectors on the first floor.

When the hot water was turned on, many convectors creaked and snapped, obviously due to the elements moving in the cabinets because of expansion of the main. The contractor was compelled to eliminate this. He did it by using flexible connectors at each end of the noisy convectors. Of course, the contractor should have known that the connections were too short in the first place. But too often such things get by and result in trouble.

The mistake often made by heating contractors is that they look at the price of a flexible connector compared with a few nipples and elbows and almost automatically say "too expensive." What they fail to consider is the time saved by not having to be accurate in roughing-in the piping and not having to solder a lot of joints. One man working alone can often do what is commonly considered a two-man job.

The best way and perhaps the only way to prove all this is for the doubting contractors to try out a few jobs. The risk is small and the potential benefit great.

The situation is much the same as when copper tubing was first introduced. Judging by the material cost alone, there seemed to be no saving. But as contractors experimented and developed skill in handling the tubing, the actual installed cost was found to be quite favorable. So, too, with flexible connectors — only in this case not more but less skill is needed.

In this age of streamlining and automation it would appear that flexible pipe connectors are merely a means of keeping in step. ∓

Photos courtesy Cobra Metal Hose Div., D. K. Mfg. Co. (Figs. 1 and 2); Anaconda Metal Hose Div., American Brass Co. (Figs. 4 and 5); and M & R Development Co. (Fig. 6).

Case Histories from a Consulting Engineer's Files

By C. T. BAKER
Consulting Engineer

Modern heating, piping, and air conditioning systems, for efficient and satisfactory operation, must be correctly designed. Here are two typical cases from the author's experience where original design was faulty and had to be corrected.

• vent evens pressure, improves flow

THE AMMONIA receiver in a meat processing plant was located out of doors and, on clear days, was subjected to sun exposure for several hours. The shell of this receiver was painted black, increasing the ability of the metal to absorb heat energy from the sun. The shell was not vented to the condenser.

Temperature readings on the exterior of the shell during periods of sunshine showed the shell to range from 10 to 12 F above the ambient air temperature.

A ½ in. vent is being installed from the top of this vessel to the top of the shell-and-tube condenser. This will cause the pressure in the receiver to equalize with that of the condenser and improve the flow of liquid from the condenser to the receiver.

• why so many liquid traps?

RECENTLY I was shown an arrangement of two refrigerant No. 12 evaporative condensers that had been installed to operate in parallel. The two compressors discharged through a common discharge line that terminated midway between the two condensers and the line connected to a common gas inlet header which tied the condensers together at the top.

A common liquid header was located below the liquid outlet of the coils of the two units. The general arrangement is shown in Fig. 1. Note that the liquid lines of each condenser are made to form a loop below the liquid header and that the liquid line extending from the common header to the liquid receiver has another loop or trap.

Why all the liquid traps when installing two or more condensers? If it is not intended to provide a free and easy flow of liquid from the condensers to the receiver, then the traps as shown are fine. But the fact remains that, when a condenser has converted superheated gas to a liquid, it's time to get the liquid away from the condenser coils as rapidly as possible so that the coils can be in shape to condense more gas.

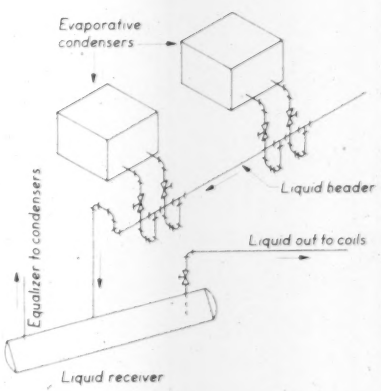
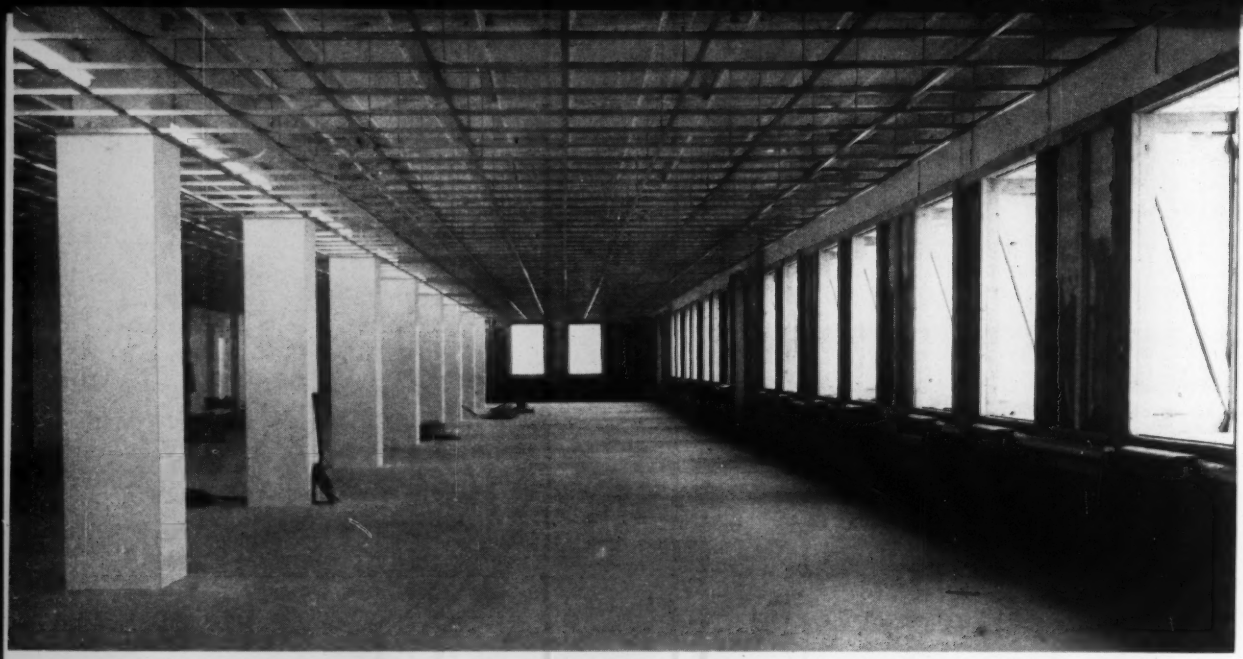


Fig. 1

Apparently there are those in the industry that have been brain-washed with the fiction that it's a bad practice to cooperate with the law of gravity when connecting the liquid outlet of the condenser to the receiver.

I have designed several installations in which evaporative condensers are operated in parallel but without traps in the liquid line. In each case the liquid outlet pipe between the condenser and liquid header drops vertically to the top of the liquid header which has an area equal to or greater than the combined area of the liquid lines connecting the condensers to the header. In addition, the liquid line is made amply large and given a slight pitch toward the receiver. The liquid inlet is at the top of the receiver shell rather than at the bottom, as is advocated by some. ∓

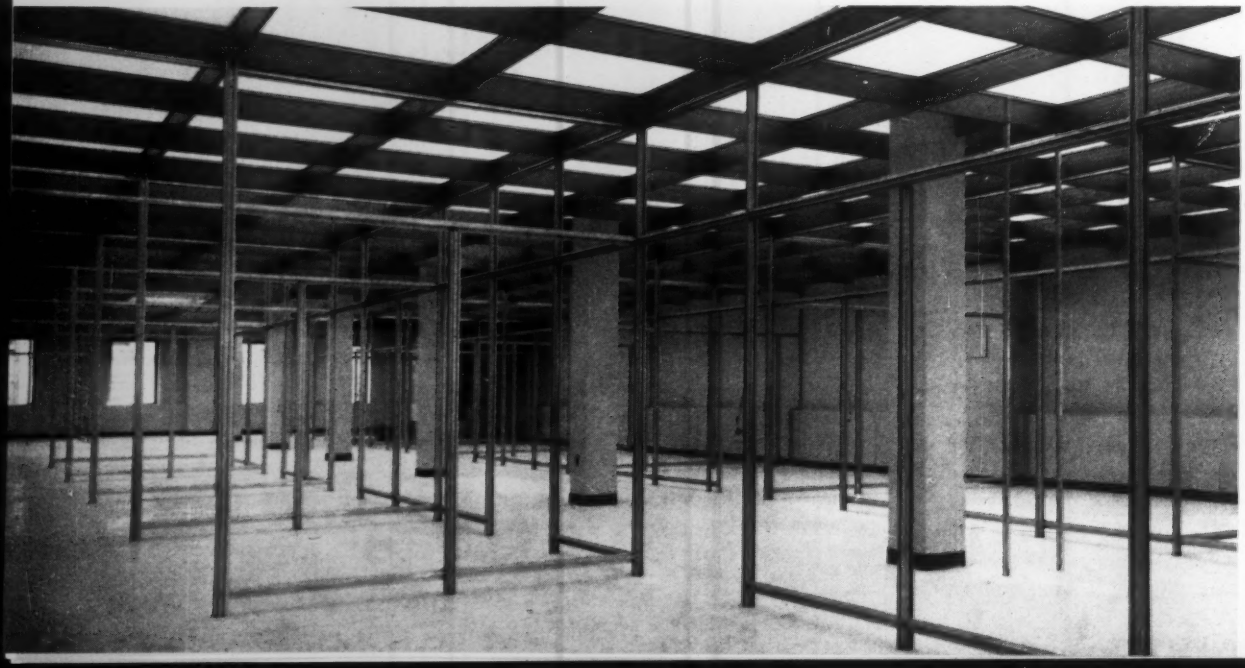


EXTERIOR ZONE is conditioned by high pressure induction system. Conditioned air is delivered from eighth floor central primary air unit to single individually controlled outlets beneath windows. Risers, which run down adjacent to building columns, each supply two to four units on each floor. Photo, taken during installation, shows units in place

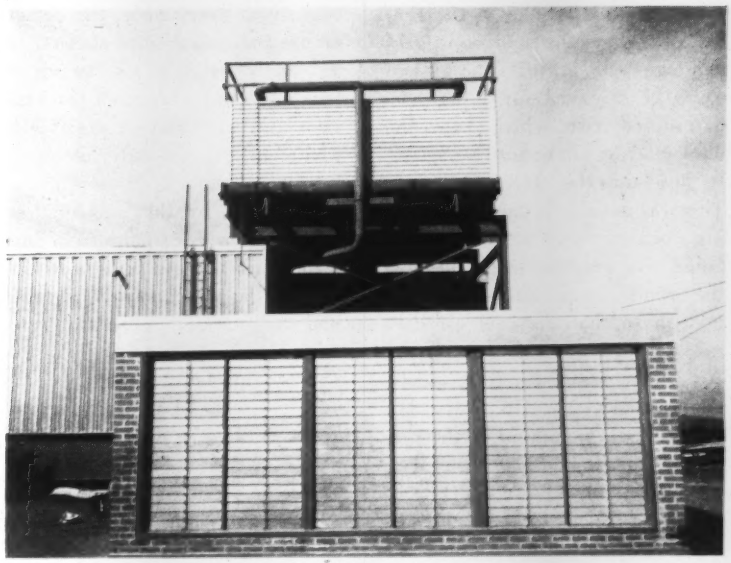
Two Separate Systems Air Condition 64-Year-Old Office Building

Overall modernization brings Cleveland's Vulcan Bldg. up to today's standards in competitive office rental market

INTERIOR ZONE, cooled year 'round, is handled by two units: one in penthouse feeds down three floors; one in basement feeds up five floors. Supply duct is installed parallel to building's center service core, above fluorescent grid and egg-crate louvers which comprise ceiling



BY ANTHONY F. MANNA
Chief Mechanical Engineer
Trygve Hoff & Associates
Engineers
and
Hubbell & Benes and Hoff, Inc.
Architects and Engineers



ROOFTOP PENTHOUSE is heart of year 'round air conditioning systems serving Vulcan Bldg.

HEATING and air conditioning the remodeled 64-year-old Vulcan Bldg., Cleveland, for its owners, the McDowell Co., who are engineers and contractors, presented several unusual problems.

The sturdy structure is approximately 100 × 160 ft, is eight stories tall, and has varying floor heights. Remodeling included an exterior curtain wall of glass and stainless steel. Comparable conversions of the interior gives Cleveland a contemporary office building at its civic center.

To obtain the most usable office space out of the building with a stairwell located in the central section, the most economical location for elevators, rest rooms, utilities, and duct shafts was the center service core.

The first floor houses retail and service businesses. The second to fourth floors are subdivided for office tenants. The McDowell-Wellman companies staff and subsidiaries in their international operations in engineering and heavy construction require the four upper floors, each about 14,000 sq ft exclusive of the center core.

The first and lasting impression of the McDowell floors is that of a glowing luminous work environment. The well-lit offices have overall suspended luminous ceilings with small egg-crate louvers to provide uniform illumination throughout the areas with minimum shadow or glare. There is no need for supplemental lighting.

In some sections, individual offices along floor perimeters are formed by movable steel-glass partitions whose tops fasten to the T-bars of the lighting system. This installation of almost three acres of fluorescent tubes on eight floors necessitated special early calculations of heat wattage losses to be handled by the air conditioning system.

With low structural ceiling heighis and the space required for suspending the lighting equipment, little space was left for ductwork, so we had to keep in mind a system requiring small ducts. Also, the selection of a curtain wall skin to cover the existing brick walls resulted in a perimeter system which distributes outdoor air into the building through small vertical ducts along the perimeter walls.

We also had to keep in mind the fact that the partitions might be moved from time to time to create larger or smaller office modules.

These basic factors and others led to a decision to use two related but independent types of systems to properly handle the varying heat loads at all seasons.

The building is divided into two zones, the exterior, using a high pressure induction unit under each window, and the interior, using low velocity along the center core walls above the egg-crate ceiling.

Interior Cooled Year 'Round

The interior zone is served by two units, one in the penthouse feeding down for the top three floors and one unit in the basement feeding up for the first five floors. The reason for this type of split was to utilize an existing elevator shaft for air supply, return, and exhaust.

The interior zone needs cooling the year 'round, even in the winter due to heavy lighting and people loads. Interior zone units use chilled water for cooling during the summer months. A mixture of outside and return air provides cooling during the winter, with outside air and a mixture of return air utilizing face and bypass dampers in the units.

With the interior zone supply

duct installed parallel to the center core, above the fluorescent grid and egg-crate louvers, the system could be designed for a high dehumidified rise which kept the total interior air quantity relatively low and the duct size small. This was possible because the lighting, located above the ceiling and being the greatest single load in the zone, heats the supply air enough so that the cool air does not descend upon the occupants. Air distribution is thus greatly simplified.

An existing chimney in the rear of the building is also utilized as an outdoor air shaft to supply air to the basement interior zone unit and an auditorium ventilation unit.

One System Cools Exterior

The outer zone — office areas adjacent to the windows and extending inward from 16 to 20 ft — is served by a high pressure induction system. The perimeter zone is supplied by a central primary air unit located in the equipment penthouse above the eighth floor.

High velocity, high pressure conditioned air is delivered through trunk ducts along the eighth floor ceiling. From here the primary air is distributed laterally to conduit air risers running down adjacent to the columns around the perimeter of the building to the first floor. Each riser supplies two to four units on each floor. A single, individually controlled unit is located under each window on either side of the risers.

The secondary water system for the exterior zone induction units is a complete reverse return system. The water supply header is above the eighth floor ceiling and the return header is along the basement ceiling. A riser is extended from the return header back to the penthouse in the center core.

With two windows between each column on every floor, the design of the induction units allowed us to supply primary air to up to four units on each runout from the riser and also made it possible to locate air risers only at every fourth column. A further advantage gained by this was that we were able to design the secondary water runouts as a reverse return, locating a water supply riser in one column and a return water riser four columns away. With the supply header, return header, risers, branches, etc., so located, we were able to design the entire water system as a reverse return system allowing for perfect circulation of water and eliminating any shortcircuiting of water to any induction units.

We also eliminated the need for insulation of secondary water piping in the conditioned space, because the induction units were selected using a water temperature above the design room dewpoint. This also led to the omission of a condensate piping system and the maintenance of same.

Unlike other floor heights, the original eighth floor ceiling followed the slope of the roof. This was 20 ft high at the front of the building, sloping to 12 ft at the rear. The new ceiling was furred down to a subceiling height of 12 ft and a finished ceiling height of 10 ft. This allowed room above the sub ceiling for the high velocity, high pressure trunk system and the supply water header, with the low velocity supply duct along the center core being installed between the sub and finished ceiling.

The framing on the roof that supported the old building water supply and fire tank is now utilized to support the new cooling water tower for the air conditioning system.

Here Are System Capacities

Equipment capacities for the systems are as follows: The refrigeration machine is a centrifugal unit with a cooling capacity of 400 tons. The preheat coils have a steam capacity of 1530 lb per hr at 5 psi (−5 F entering air and 50 F leaving air); reheat coils have a steam capacity of 2340 lb per hr at 5 psi (56 F entering air and 140 F leaving air). The spray coil eight-row dehumidifier has a capacity of 460 gpm, 43 F entering water, 51.8 F leaving water, and 48 F apparatus dewpoint. Fan capacity is 24,140 cfm at 8.5 in. water gage with a 50 hp motor; and the heat exchanger has a steam capacity of 4100 lb per hr at 5 psi (523 gpm with 125 F entering water and 140 F leaving water).

The pumps used for the system are: a primary pump with a capacity of 810 gpm at 50 ft head and a 15 hp motor; a secondary pump with a capacity of 523 gpm at 70 ft head and a 15 hp motor; a condenser water pump with a capacity of 1110 gpm at 65 ft head and a 25 hp motor; and a spray water pump with a capacity of 37 gpm at 19 ft head and a ½ hp motor.

The cooling tower is rated 1110 gpm at 96.8 F entering water and 86 F leaving water with 75 F design WB and a 15 hp fan motor.

The interior zone unit in the penthouse has a fan capacity of 18,510 cfm at 1.5 in. WG with a 15 hp motor and a four-row cooling coil having a capacity of 152 gpm at 43 F entering water, 51.5 F leaving water, and 52 F apparatus dewpoint temperatures.

The interior zone unit in the basement has a fan capacity of 22,435 cfm at 1.6 in. WG with a 15 hp motor and a four-row cooling coil having a capacity of 198 gpm, at 43 F entering water, 52.3 F leaving water, and 52 F apparatus dewpoint temperatures.

The systems have been in operation for one season and no performance problems have been experienced. ±

Photos courtesy The Wakefield Co. and Carrier Corp.

How to Write, Use a Computer Program For Calculating Pipe Stresses

● In the January issue[1] the author presented a set of formulas with which one could write a computer program for the calculation of pipe stress. However, there is a lot to stress analysis that does not show up in the formulas, and a programmer would need more information to actually write and debug a workable program. This article will attempt to explain the problem in rather general terms in order to help the programmer write the program and to help the designer use the program intelligently after it is written.

Mr. Bridge has had 15 years' experience with the du Pont Co. in the power and piping field, and 10 years since then with various construction companies in the design of chemical and petroleum plants. For the past seven years he has been employed by the Catalytic Construction Co. He is currently working with a group of engineers at Oak Ridge, Tenn., on the design of a high energy cyclotron. This is the sixth article that Mr. Bridge has authored for Heating, Piping & Air Conditioning.

BY THEODORE E. BRIDGE
Piping Design Consultant

PIPING, in conveying fluids from one piece of equipment to another, often acquires temperatures much higher than it had when it was installed. All materials expand when heated. Steel, for example, expands $\frac{3}{4}$ in. per 100 ft for each 100 F to which it is heated. But the equipment to which the piping is attached does not move, or it may move in the wrong direction.

As a result, the piping is crowded into a space smaller than it wants to occupy. It fights back — producing a locked stress in itself and a pattern of forces and bending moments at the equipment to which it is attached. By making a very tedious calculation, we can estimate quite accurately the magnitude of the stress and forces that remain locked in a heated piping system.

Now that we have computers we can make extensive calculations economically. But is it worthwhile? We can make an accurate estimation of the push of a pipe on a pump, but we do not know if it is allowable or not. Where we formerly had to guess what the push was, we must now guess whether or not the pump will take it. Much work remains to be done to set limits for allowable pipe thrusts on equipment, and every manufacturer naturally has his own ideas.

After studying the rules in the NEMA code for mechanical drive turbines, and based on our own ex-

[1] *New Formulas Aid Computer Solution of Piping Design Stress Problems*, by Theodore E. Bridge. Heating, Piping & Air Conditioning, January 1960

Engineer should consider piping

perience, I would like to propose the following standard as a rough guide until we get something better.

1) For mechanical drive turbines and centrifugal gas compressors:

$$F = 50\ D$$
$$M = 300\ D$$

where:

D = nominal diameter of the pipe connection to the turbine, in.
F = allowable thrust of the pipe on the turbine, lb
M = allowable resultant bending moment on the turbine, lb ft.

2) For pumps designed for high temperature with centerline supports, multiply the value obtained for turbines by 5.

3) For all other rotating equipment, keep the bending stress in the pipe at point of attachment to the equipment below 4000 psi. For the purpose of this calculation, assume the pipe to be the same size as the nozzle to which it is connected.

4) For boilers, heat exchangers, tanks, etc., keep the bending stress in the pipe at point of attachment to the equipment below 5000 psi. For the purpose of this calculation, assume the pipe to be the same size as the nozzle to which it is connected.

Must Design Before Choosing Equipment

A standard like the one proposed above is very much needed, because it is necessary to begin the design of the piping before the equipment has been selected. An equipment vendor may sometimes take exception to the proposed standards. Therefore it may sometimes be necessary to redesign the piping to comply with his requirements.

The engineer should give consideration to the flexibility of the piping very early in the design. Corrections can then be made by relocating the equipment when it is necessary to obtain more flexibility. In this way, a flexible piping system can be designed very economically.

Enter Input Data

If a computer program is available, based on the formulas presented in the January issue, it is necessary to present to the machine, the coordinates at the apex of each elbow. Before this can be done, certain other work is required.

First, the programmer must study the drawings and visualize one system that is to be analyzed. He must:

1) Pick an anchor at one end and label it zero

2) Assign odd numbers to each of the other anchors in sequence

3) Assign even numbers in sequence to the pipe joining each anchor branch.

The first number to be entered into the machine, will be N (the number of anchors). From this, the machine will calculate Ne (the number of equations that must later be solved).

$$Ne = 6\ N - 6$$

Next, the anchor at point zero must be considered fixed and the motion of all other anchors calculated with respect to it. There will be three components of angular rotation and three components of motion to be entered for each anchor. Many of these (perhaps all) will be zero. There must be one entry for each equation.

Nine entries for each pipe member will follow into the machine. From each group of nine entries, the machine will calculate a 6×6 matrix of shape constants for the member. These will be added to others calculated for members previously entered. A separate total will be kept for each branch.

The first three entries in a group of nine give the

south, *up*, and *east* coordinates at the apex of the elbow. An elbow is always assumed on the remote end of a straight piece of pipe. If an elbow does not exist here, enter the coordinates at the remote end of the member and enter $R = 0$. If straight pipe does not exist, i.e., if an elbow immediately follows the last point entered, the machine will find it out. It will find that the length of straight pipe is zero.

Always start at the anchor and work inward toward the juncture point. The coordinates at the anchor will be entered first. The machine will assume that a member runs from the previous point entered to the present anchor point, and the designer must correct for this false assumption on the first entry. This could be done by entering zero for B and infinity for I.

Since it is impossible to enter infinity, the programmer must make provision for skipping the calculation of shape constants if a zero is entered for I. Thus the effect of a nonexistent pipe between the last point of one branch and the first point of the next will be ignored by inserting zeros for I and B on the first entry of a new branch.

A valve or a heat exchanger installed to float with the piping can usually be assumed to have infinite rigidity. If this is desired, consider it as a member having $I = 0$ and $R = 0$, but enter a correct value for B.

Two Alternatives in Scaling

The programmer will have to give a lot of thought to the subject of scaling. He has two choices:

1) He may use floating point numbers

2) He may use fixed point numbers.

The use of floating point numbers will solve his problem, but it may add hours of time to the calculation.

In a floating point program, the machine keeps track of the decimal point. It continually shifts numbers to the left end of the register, thus maintaining the maximum accuracy during the calculation. But this takes time. A simple addition or multiplication may require many operations. In the solution of 30 simultaneous equations, the machine will be required to execute one part of the program 13,500 times. If this is optimized as much as possible, it would take 30 to 40 min on a Royal McBee computer using a fixed point program. If a floating point program were used, it might take a prohibitive amount of time.

On the other hand, very careful attention must be given to scaling if the required accuracy is to be obtained using fixed point numbers. If numbers are carried too far to the left in the register, overflow will occur. If they are placed too far to the right, accuracy will be lost. In the solution of the simultaneous equations, differences between large numbers are obtained. If numbers are not kept at the significant end of the register, the entire number may be lost when making one of these subtractions.

In a fixed point program, the machine assumes a decimal point at the left end of the register. Thus all numbers are less than 1 as far as the machine is concerned, but the programmer must keep track of the real location of the decimal point. He must guard against overflow on one hand and loss in accuracy on the other. Therefore, a programmer not familiar with pipe stress should be very interested in the following recommendations on scaling. In making the recommendations, we gave due consideration to the range through which the quantities might vary.

Distances will be entered as 100 ft. Thus a coordinate (35.0 ft) would be entered as (0.35 hundred ft) The real number (35) is multiplied by (10^{-2}) to give the number that appears in the machine. The negative power of 10 used for scaling is called the scale factor (Q). Thus: ($S = 35$); ($Qs = 2$); the machine sees:

$$S \times 10^{-Qs} = 0.35$$

In the following table we list all of the input data symbols, together with the suggested scale factor, Q, and a description of the symbol.

Symbol	Scale factor, Q	Description
Y	5	Angular displacement at anchor, radians
Z	5	Motion of the anchor, in.
S	2	*South* coordinate at the apex of the elbow, ft
U	2	*Up* coordinate at the apex of the elbow, ft
E	2	*East* coordinate at the apex of the elbow, ft
K	2	Flexibility factor of the pipe bend, dimensionless
B	5	Thermal expansion factor, in. per 100 ft
R	2	Radius of bend, ft
I	See note	Moment of inertia of pipe section, in.^{4}
E^*	8	Young's modulus of elasticity, psi
N^*	6	Number of branch in which member is located
1728.0	4	Constant, cu in. per cu ft
M	See note	Answer. Moment at anchor, lb ft
F	See note	Answer. Thrust at anchor, lb

Note: The answer in thousand lb will come out scaled the same as I. I must be scaled with the most significant end of the register occupied. Otherwise, overflow will occur when the length is divided by $E\,I$ in the calculation. Thus, the scale of the answers will be: for force (F) $= Q_f = Q_i + 3$; for moment (M) $= Q_m = Q_i + 5$.

Consider the following examples: For a 3 in. pipe, $I = 3$. The scale factor for I would be $Q_i = 1.0$ and the answer would come out in thousand lb if the decimal is put one place in from the left end. If the answer came out 006 539 218, it would be read 0.06539218 thousand lb. Or, if you prefer, you could read it 65.39218 lb.

For a 12 in. pipe, $I = 300$. The scale factor for I would be $(Qi = 3)$ and the same answer as above would read 6539.218 lb.

If the total length of the piping system in one direction exceeds 50 ft, the coordinates and the radii must be scaled at $Q = 3$, or in thousand ft. In this case the answer in pounds will come out to the same scale as I. Thus, the scale of the answers will be: for force $(F) - Q_f = Q_i$; for moment $(M) - Q_m = Q_i + 3$. This is necessary to prevent overflow during additions in the calculation.

This system of scaling should give the required accuracy without causing overflow during the calculation. It may seem a bit complicated at first, but should be learned quickly with a little practice. Considerable machine time will be saved by avoiding the use of a floating point program.

Checking for Accuracy

The accuracy of computers is very good, as compared with human standards. But they can make mistakes. In a six-anchor pipe stress problem, several hundred thousand operations must be performed. Each one is a chance for making a mistake.

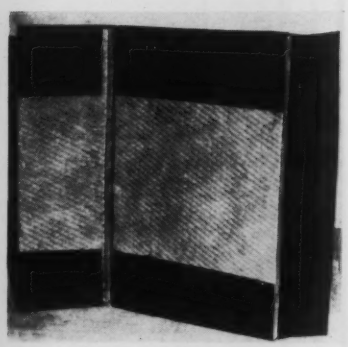
Some computers have built-in facilities for checking each operation as it goes along. Others have eliminated this feature, thereby making a big saving in the cost of the computer. The programmer may, if he wishes, insert a checking procedure in the program, but this could be very time consuming.

One way of checking the answer would be to repeat the problem using the same data. This would be a lot quicker than to insert continual checking step by step in the program, but it might not give a positive check. A better way would be to repeat the problem taking the branches in a different order. This would give the same answers from an entirely different set of equations and should give a foolproof check.

A simpler way, and one that would be quite satisfactory for many cases, would be to compare answers obtained from similar problems using human judgment. Most computers have been trained to make a big mistake when they do make one. Their accuracy is far better than the accuracy of the manual calculations that we have had to rely on in the past. ∓

Notched Sheets Insulate Air Conditioning Ducts

. . . reduce exposed longitudinal seams



EXPOSED LONGITUDINAL SEAMS on ducts, ranging in size from 12 in. square to 36 in. square, were covered by unique application of spun felt insulation sheets

SPUN FELT insulation sheets were used to cover the air conditioning ducts in the new U. S. Public Health Service Hospital in Carville, La. The ducts range in size from 12 in. by 12 in. to 36 in. by 36 in. The 48 in. insulation sheets were notched to reduce the number of exposed longitudinal seams. Sheets were first notched with a knife to correspond to the edges of the ducts, then wrapped about the duct leaving its edges protected by the vapor barrier paper cover, according to Baldwin-Ehert-Hill, Inc.

Instead of the four open seams usually resulting by application of sheets to each side of the duct, this procedure required from one to three seams per section. A 4 in. "overlap" of the vapor barrier paper provided increased moisture protection for the insulation at the seams. Aluminum bands were used to tie the insulation to the ductwork, and asphalt mastic was used to seal the circumferential seams.

Four floors of air conditioning ductwork were insulated in each of the two hospital buildings in this manner by Samdot Insulations. ∓

SAMUEL R. LEWIS, consulting mechanical engineer and a member of Heating, Piping & Air Conditioning's board of consulting and contribution editors, comments informally on practical problems in the field.

Sam Lewis says:

"The Day of Open Stairways in Primary Schools Without Automatic Sprinklers Is About Past"

WE ALL will recall the horrible Chicago Holy Angels school fire in the late fall of 1958 in which so many little children were killed—largely because escape routes via the smoke-filled open stair shafts were not utilized.

Fortunately, the day of open stairways in primary schools without automatic sprinklers appears to be about past. As proof of the imminent danger of this outdated type of construction, the National Fire Protection Association and Raymond M. Hill, Los Angeles fire marshal, have cooperated to issue an enlightening report which relates the results of test fires conducted in a condemned Los Angeles school building.

While most school buildings of recent construction have masonry floors, partitions, and walls, many of those with more than a single story still have open stairways. In some cases the heating and mechanical ventilation are combined with local air recirculation within each room, but without individual fire-resistant flues from each classroom leading out of doors through the roof.

In others the spent air from each classroom flows from it to the corridor and ultimately passes up the stairways to openings in the ceiling of the top story corridor. If a fire should occur in such a building, the smoke and gases would block escape via the stairs.

Los Angeles had an elderly three-story school building, which was to be demolished. In an educational gesture, the Los Angeles board of education, the state fire marshal's office, and the city fire department participated in a program for testing the life-safety features of various equipment by setting fires within the school. Total cost in funds spent and materials contributed was about $100,000.

Automatic sprinklers, smoke detectors, temperature indicators and recorders, roof ventilators, various fuels, and materials for smoke barriers were contributed.

Building walls were masonry, corridor floors and top stairs were concrete, classroom floors were of wood and wood joists, and the roof above the third story was on wood rafters.

Almost 60 fires were started. Various effects as to smoke and temperature were photographed and recorded.

In one of the tests, originating in the basement, the firemen timed untenable smoke conditions as follows: first corridor, within 2 to 3 min; second corridor, 4 min; and third corridor, 4½ to 6 min. The length of time was influenced by whether the windows were partly open. The top endurable temperature was assumed at 150 F. This increase was reached in about double the time required to reach the untenable smoke condition.

Following a fire started in a classroom, open windows and transoms accelerated the adverse conditions of smoke and heat in the corridors.

Large vent openings through the roof above two open stairways were provided. If these were open so that smoke and heat could escape, a very slight delay in untenability in the corridors was gained over the time of untenability when they were closed. With the vents open, the fire burned more intensely and the 150 F temperature limit was reached much more quickly.

There was an impression therefore that such vents of 42 sq ft area at the roof over each stair shaft, opened only by springs or counterweights and responding to fusible links, are not satisfactory.

Vents did eventually clear the smoke from the corridors, but when this occurred, temperatures 5 ft above the floor were recorded as follows: first story, 120 F; second story, 290 F; third story, 214 F. The lower temperature on the third story probably was due to the vents through the roof being open.

Tests were made with barriers extending down from the corridor ceilings at entrances to stair shafts and at the center of each corridor so as to limit the passage of smoke and gas below a level 7 ft above the floor. The smoke spread through the building almost as rapidly after these barriers had

been installed as it did before.

Tests of automatic sprinklers disclosed that unless the sprinkler coverage was complete and a head was near or directly above the fire, the smoke made the building untenable before the sprinkler opened. In tests simulating partial coverage, when the sprinkler heads opened, the firemen left hurriedly because the falling spray of water drove the hot air and gas down to such an extent that the resultant steam obscured their vision.

With a hot fire in a classroom, and with sprinklers operating in the adjacent corridor, the sprinkler effect confined the burning to the classroom, but untenable smoke conditions were observed throughout the building.

Tests made with forced draft to exhaust the smoke in the stair shaft ventilators resulted in increased fire intensity. Untenability became complete on all stories in less than 2 min.

A study was made of the life-safety problem by making a complete enclosure of a stair shaft. If doors from corridors to such shafts are automatic self-closing, that is, normally open, but close automatically on the actuation of a heat sensitive device, the smoke in case of fire would make the stairs untenable before the doors could close.

Automatic rate-of-rise fire detection equipment was installed at the ceiling of the first-story corridor. The rate-of-rise instrument reacted within 2 to 5 min in 19 out of 25 basement fires. The variation in time was due to differences in the intensity of the test fires. A smoke detector in the stairway where the fire started operated in 2 seconds, 21 seconds, and 66 seconds during three basement fires.

While the conclusions to be drawn from these fire tests are a matter of individual study, a few interpretations seem obvious.

"Partial sprinkler protection" did not appear to be acceptable except on recommendation of a competent fire protection engineer after a careful evaluation of all factors relating to the problem. Vents over stair shafts and the installation of smoke barriers at stair shaft entrances and in corridors are not of sufficient value to be recommended.

A complete automatic sprinkler system, interconnected with the school fire alarm system and with the community fire department, may be acceptable. And there should be safer means of exit than interior corridors between two rows of classrooms to stairways where congestion may occur. ⫩

Sectional Committee Interprets Code for Pressure Piping

Since the Code for Pressure Piping, ASA B31, was last issued, the Sectional Committee on the Code has been asked to interpret various statements contained therein. While these Cases represent the opinion of the committee, they will not become parts of the Code until formal actions have been taken.

Case No. 44

Inquiry: The latest edition of Section 1, ASA B31 is 1955. In view of the extensive re-evaluation that has taken place since that time, what joint factors may be applied to fusion welded pipe made to ASTM Specifications A-155 or A-358 fully radiographed?

Reply: Pending the publication of the next edition of ASA B31.1 Code for Pressure Piping, it is the opinion of the committee that the intent of the Code will be met if a joint factor of 1.0 is used for pipe made under these specifications in which the pipe has been fully radiographed as required by these specifications.

Case No. 45

Inquiry: Paragraph 845.42(a) states that liquid seal relief *valves* must close when the pressure in the distribution system returns to normal. Does this preclude the use of manual resetting relief valves under the rules of Section 8 of the Code for Pressure Piping, ASA B31.8-1958?

Reply: It is the opinion of the committee that Paragraph 845.4, Section 8 of ASA B31.8-1958 should be amended to read as follows:

"845.4: *Control and Limiting of Gas Pressure in Low Pressure Distribution Systems*

"845.41: Each low pressure distribution system or low pressure main supplied from a gas source which is at a higher pressure than the maximum allowable operating pressure for the low pressure system shall be equipped with pressure regulating devices of adequate capacity designed to meet the pressure, load, and other service conditions under which they will have to operate.

"845.42: In addition to the pressure regulating devices prescribed in 845.41, a suitable device shall be provided to prevent accidental overpressuring. Suitable types of protective devices to prevent overpressuring of low pressure distribution systems are:

"(a) A liquid seal relief *device* that can be set to open accurately and consistently at the desired pressure," etc. ⫩

Nomograph Gives Quick Graphical Solutions For Outdoor Reset Control Performance

BY JOHN SCHWARTZ
Field Engineer
Automatic Controls Div.
Barber-Colman Co.

HOT WATER heating systems today are frequently controlled, in part, by resetting supply water temperature in accordance with outdoor temperature changes. As outdoor temperature drops, the supply water control point is adjusted upward in a predetermined manner. When outdoor temperature rises, the water temperature is lowered.

This form of control is achieved by using a temperature sensing element exposed to outdoor temperature, and another element immersed in supply water. The sensing elements, acting as a ratio or master-submaster controller, position a valve to obtain the desired supply water temperature. (Sometimes reset is achieved through variation of boiler water temperature by controlling burner operation from the outdoor reset system.)

Outdoor reset controls are usually supplemented by final control from zone or room elements regulating the heating surfaces in the building. Outdoor reset provides several important advantages, including:

1) Anticipation of outdoor temperature change before the effect penetrates the building

2) Final control components are better able to function as intended when part of the throttling load is shared by the reset controls

3) The tendency toward overheating in mild weather, with ensuing fuel waste and discomfort, is avoided.

In ratio control systems, whether the above application or in some other form, there exists a definite relationship among the two temperature variables and the reset ratio.

The nomograph on the next page provides a convenient way to determine performance of hot water systems to which outdoor reset control is applied. Conditions known to the designing engineer are:

1) Outdoor design temperature

2) Supply water temperature required at the outdoor design temperature.

Conditions 1 and 2 determine performance at the high end of the water temperature range for maximum heat output. The low end of that range and the corresponding outdoor temperature form two other conditions of the relationship which may be noted as follows:

3) Outdoor initial temperature

4) Supply water temperature desired at initial outdoor temperature.

A typical value for the initial outdoor temperature at which supply water temperature will be low is 70 F. The desired water temperature at an outdoor temperature of 70 F may be 70 F, as given in the nomograph example. A starting place is thus chosen for the reset schedule. It may be thought of as the supply water temperature control point when reset action is nil, or zero.

Frequently, water temperature higher than 70 F is selected as the starting place, since some heat output may be required to warm up a building on a morning when the outdoor temperature is 70 F after lower night temperatures. The type of radiation also influences selection of the initial water temperature. The initial outdoor temperature, too, may be selected at values other than 70 F. The nature of the building and occupancy determines the outdoor temperature at which heating output should cease.

From conditions 1 through 4 the ratio or slope of the system performance curve is fixed and may be determined from the nomograph.

Another useful application of the chart is the easy solution for supply water temperature at outdoor temperatures other than design. Thus, system characteristics can be quickly observed for the entire range of the reset schedule—without making numerous, time-consuming calculations.

Similarly, the designing engineer may experiment on paper with several values of one or more of the variables during the calculation stage of the heating system design. The reset performance resulting from trial design is readily determined from the nomograph.

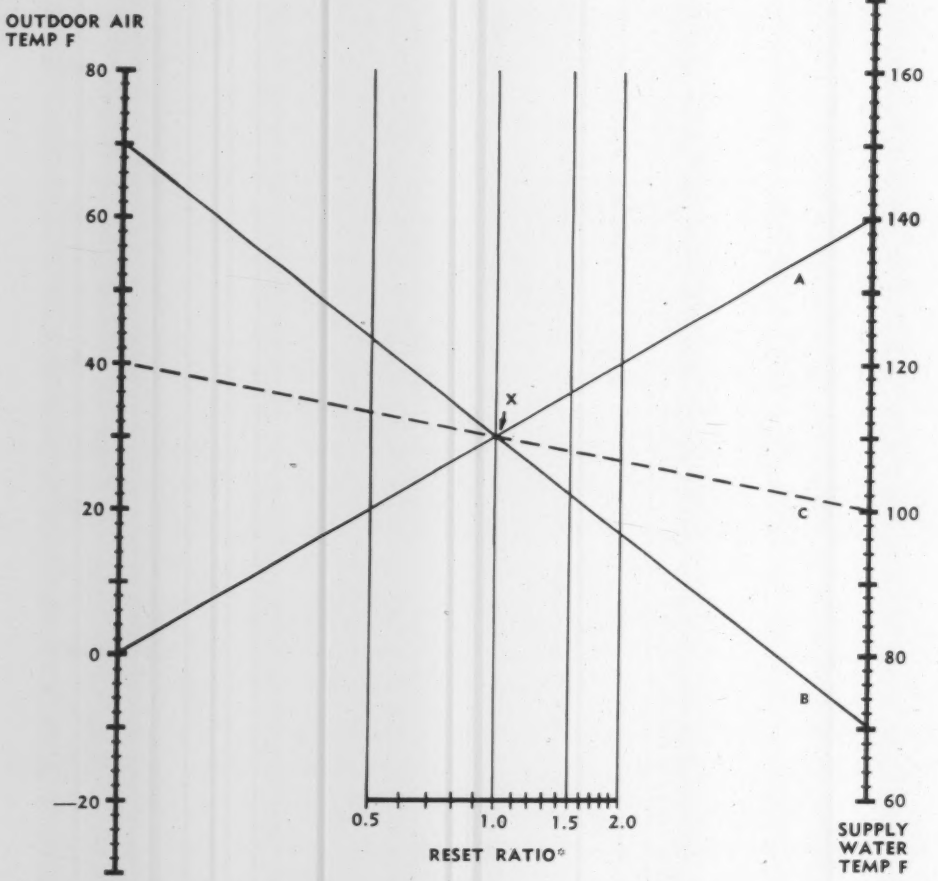
Example using assumed values:

A—Find **reset ratio***

1) On the outdoor temperature scale, mark the outdoor design temperature (zero F).
2) On the supply water scale, mark the desired water temperature (140 F) when outdoor is at design.
3) Draw line **A** connecting points determined in Steps 1 and 2.
4) On the outdoor temperature scale, mark the initial outdoor temperature (70 F).
5) On the supply water scale, mark the initial water temperature (70 F) corresponding to the initial outdoor temperature of Step 4. (This is the water temperature control point when reset action is zero.)
6) Draw line **B** connecting points determined by Steps 4 and 5.
7) Through the intersection (**x**) of lines **A** and **B**, draw a vertical line to the **reset ratio** scale. In this example, the ratio is 1.

B—Find the supply water temperature at any outdoor temperature for a given reset ratio

1) Lines **A** and **B** intersect with the ratio line.
2) Through intersection (**x**) thus formed, draw the line **C** from the selected outdoor temperature (40 F).
3) Intersection of line **C** with the supply water temperature scale marks the water temperature (100 F) at the selected outdoor temperature for the reset ratio chosen.



$$\text{*RESET RATIO} = \frac{\text{CHANGE IN OUTDOOR TEMP.}}{\text{CHANGE IN SUPPLY WATER TEMP.}}$$

PERFORMANCE of hot water heating systems to which reset control is applied can be determined very conveniently using this nomograph. See preceding page

the law and your profits

JOHN F. MORRISSEY, author of this regular feature, is an attorney at law and has an extensive practical business and legal background. This series is based on actual cases. All names are, however, fictitious. It should, of course, be remembered that the law varies in different states.

It's Contractor's Duty to Advise Owner Of Problems Leading to Poor Operation

EACH PARTY to a contract must see to it that the other performs according to the terms of the agreement in order to avoid a possible waiver of the other's obligations. After work is completed under a contract it is often too late to complain about some unfulfilled obligation where there was knowledge and acquiescence at the time of obligation. This will be made clear by the following:

Restaurant owner Les Flow, after resisting progress for years, decided that air conditioning would help his business. Flow contracted with S. I. Lence Heating & Cooling Co. for the installation of an air conditioning system in the restaurant.

The contract price was $1050. Flow paid $2500 on account, leaving a balance of $1550.

After the installation was completed, Flow refused to pay the balance, charging that the system did not perform its function. Lence brought suit against him for the balance due. On the advice of counsel, Flow filed a counter-claim against Lence, alleging that he was damaged to an amount in excess of the balance withheld.

"The situation is this," Flow told the court. "The system did not work properly, and nine months after the installation I moved my restaurant to another location. I hired another company to remove as much of the system as could be salvaged and to reinstall it at the new location.

"Since Lence breached the contract by installing a faulty system, and that part which I salvaged is worth only a fraction of the original contract price, not only do I owe him nothing, but I am entitled to a rebate of a portion of the money paid him."

The court agreed with Flow and rendered judgment in his favor. It found the value of the salvaged system to be only worth $1000 and ordered Lence to pay Flow $1500.

Lence appealed to a higher court, and argued, as he had in the lower court, that under the terms of the contract Flow was to supply a water line of sufficient size to any point within 10 ft of the air conditioning unit.

"The only thing wrong with the system," said Lence, "was the inadequacy of the water supply, which was the fault of Flow."

The higher court reviewed the evidence and found it to be true that the failure of the system was due to the inadequate water supply.

"Certainly," said the court, "the responsibility for the water supply must be placed upon either Flow or Lence. There has been no pretense that any demand was made on Flow to supply a different sized line. His contract obligated him to supply a water line of 'sufficient size' and, if the water line was insufficient, it was the contractor's duty to notify him and demand another water line. Flow, a restaurateur, certainly was in no position to determine what amount of water was necessary to the successful operation of the system.

"Flow," continued the court, "is obligated to pay for that part of the system salvaged and utilized by him. Since Lence offered no evidence in the lower court to dispute the worth of the salvage, we must accept that offered by Flow that places the value at $1000."

The higher court affirmed the rulings and judgment of the lower court in favor of Flow.

Lence fared rather poorly in this matter. But, as the contractor, he should have been aware in the beginning that the water supply was inadequate and demanded of Flow that he rectify the situation according to the contract. ±

BY JOHN W. MARKERT
Supervisor
Air Conditioning, Ventilation, and Heating
Gibbs & Cox, Inc.
Naval Architects

"FLOATING HOTELS," modern passenger liners must provide occupants with all the comforts of land installations. Design of air conditioning is complicated by many factors

A STUDY IN CONTRAST:

How Shipboard Air Conditioning Compares to Land Installations

• An interesting comparison can be drawn between the air conditioning design for today's passenger liner and that for its land-locked counterpart, the modern hotel. As caterers of comfort, they are alike in that they must satisfy the whims of a clientele that expects the best. These two structures are similar in many functional respects and, in fact, have many features in common. But the structural requirements of a ship and its infinite mobility present considerations which impose unique design problems. Some of these problems and the means taken to compensate for them are discussed in this article.

A PASSENGER SHIP often has been referred to as a "floating hotel." As a matter of fact, in the field of naval architecture, a ship's ventilation, heating, and air conditioning is known as one of the various "hotel services." For this reason, it seems appropriate to compare shipboard air conditioning with that type of land installation.

Being similar in many functional respects, both installations have:

1) A large number of small rooms
2) Public rooms for eating and entertainment (dining rooms, ball rooms, etc.)
3) Working spaces (kitchens, pantries, bars, etc.)
4) A high degree of fire integrity
5) Continuous operation all year 'round, 24 hours a day
6) Occupants requiring high quality performance.

On the other hand, the ship is different from the hotel in other respects. Some of these differences which lead to problems are:

1) Mobility, which concerns design conditions and zoning
2) Compactness
3) Watertight boundaries and integrity
4) A large amount of high conductivity in steel structure
5) Lack of uniformity between layouts of decks
6) "Windowless" areas.

The large number of small rooms immediately associates itself with high owning and operating costs. Individual room thermostatic control, all year 'round, is essential to high quality performance. Variations in loads from room to room are great (occupancy, lights, and solar). This requires the flexibility of simultaneous heating and cooling demands. Bucking of heating and cooling mediums to provide this flexibility is essential.

The problem of high occupancy loads in public rooms is common. This involves "cooling" all year 'round when public spaces are occupied. Rates of total air change are high, frequently being 4 min or less. Ceiling heights on shipboard, except for "two-story" dome areas, are considerably lower than on land, seldom being over 9 ft—even on the largest ships. While some consideration has been given to separate "smoke removal systems" for public spaces aboard ship, only periodic purging with 100 percent outside air is presently used.

Air conditioning systems serving public spaces, like others aboard ship, do not provide humidification. Humidistats are frequently used in the larger public spaces, but these function only as high limit control during the cooling cycle.

Systems serving smaller public spaces are combined to reduce installation cost, and the inherent disadvantage of reheat control operation must be tolerated.

Working spaces such as galleys, pantries, and bars provide similar air conditioning problems, namely, confinement of heat, vapor, odors, and noise. Since unrecirculated air is frequently exhausted through these spaces, the maintenance of balance is essential to proper operation of air conditioning systems serving dining rooms and other connecting areas.

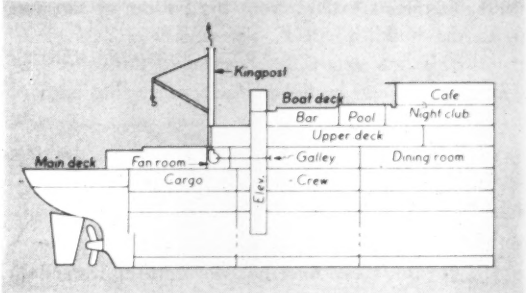
On shipboard, facilities are provided to permit the occupant of work spaces to control the blast from the supply outlets. While theoretically dampers should not be provided, the operating personnel are temperamental and insist on same.

Great effort is made to discharge galley and pantry exhausts away from air intakes and passenger deck areas. There is nothing that will make a slightly seasick person sicker than such odors. In some cases, false "stacks" must be fitted. In others, the king posts (masts) can be utilized to serve this purpose.

In a hotel, the main control of fire is vertical isolation of each floor from adjacent ones. Also, where the individual floor areas are very large, they will be further subdivided by fire partitions. In addition, safety areas are fully protected. In many localities, regulations prohibit use of corridors for returns. Shipboard fire protection, on the other hand, places the greatest stress on horizontal spread.

Except for protection of accesses, vertical subdivision is not a prime consideration. Obviously, the limitations in extent of fire zones and use of corridors, passageways, and stairwells for air return paths are basic considerations in the design of an air conditioning system for any structure. Reduction of fire hazards is, of course, a prime factor. This is controlled by using construction materials which do not support combustion or give off fumes which will impair fire fighting.

In general, it may be said that shipboard fire requirements are more stringent, which is to be expected. For one thing, except for a small fire watch, all other fire fighting must be done by persons whose primary duties are other than to fight fires. Therefore it is most important to eliminate the "human element." Many materials used on land, such as wood



TO DISCHARGE galley and pantry exhausts up and away from air intakes and passenger areas, king posts are sometimes used

and many insulations, cannot be used on ships without severe penalty.

On shipboard, the general concept requires that one fan room shall serve only spaces in one main vertical fire zone. At present, automatic smoke or fire detection systems are not directly tied-in with the air conditioning and ventilation. In some cases, galley exhaust systems are interlocked with CO_2 smothering systems.

Continuous Operation Is Compounded

On first thought, one may say that year 'round continuous operation is the same for a ship as it is for a hotel. However, a hotel will go through a complete heating and cooling cycle only once a year. On a ship, this cycle will occur many times each year. This, of course, chiefly concerns the refrigeration equipment, since most of the main heat producing equipment (such as the boilers) is in operation regardless of climatic conditions. Shutdown time is considerably less and, for this reason, reliability and ruggedness of machinery is of greater significance aboard ship.

Ship engineers are just as conscious of fuel economy as are other engineers. In the beginning their practice was to shut off systems serving unoccupied areas when the ship arrived in port. But, the problems associated with pulldown and frequent use of public spaces for special functions while the vessel is in port tend to encourage continuous operation of air conditioning facilities. In this regard it is important to note that special attention is given to foyers, lobbies, and similar areas where visitors and passengers congregate before sailing. A comfortable atmosphere does much to provide a good impression to the traveler, and is a good advertisement to the visitor who is always a potential one.

Those who travel by ship demand the same high comfort standards as guests in a first-class hotel. All who have travelled extensively have had unpleasant experiences. Odors, overheating, noise, and drafts are the main culprits. In the transportation field, ships alone afford a standard of comfort comparable to a first-class hotel. A ship, like a hotel, earns a reputation for its service—or lack of it.

Up until about 1955 most air conditioning for hotels was for existing structures. The "air conditioning" was, in most cases, the addition of cooling, since existing heating facilities were usually adequate. While many of these installations were of poor quality, they satisfied the public. On the other hand, most passenger ships afloat today originally were built with complete year 'round air conditioning. Percentagewise, it is believed, therefore, that the average shipboard installation is of higher quality than that of most hotels.

Most large ships encounter a wide range of weather conditions. It is therefore necessary to consider the extreme range of temperatures to be encountered and to arbitrarily select design criteria. The hotel, being a fixed structure, has well-established criteria. Obviously, the extreme ranges for shipboard service will involve less efficient overall performance than most land installations.

Mobility also continually changes a ship's orientation to the sun. Thus, while certain economy can be achieved on land by utilizing solar compensated zone systems, such cannot be effected aboard ship. Shipboard zoning is usually more or less arbitrary and the evaluation is made basically on the heating cycle. Obviously, this is not a very effective method, since the lighting and solar loads vary considerably, and individual room thermostatic control is ultimately required for quality performance.

Shipboard Installations Much More Compact

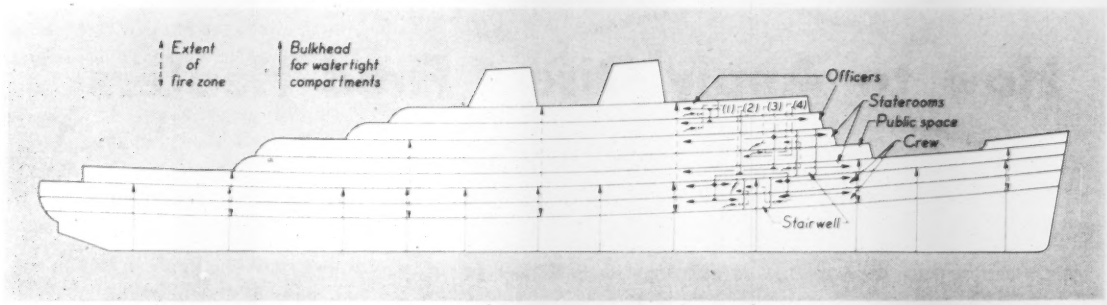
In the overall picture, the shipboard installation is much more compact than that of a hotel. Deck heights vary from 8 to 9 ft, except in a few very large public spaces, compared to floor heights of 10 to 12 ft in a hotel. Also, space for equipment is so limited on board ship that equipment arrangements are usually made two or three times to get the best compromise between economy of installation, efficiency of performance, and accessibility for maintenance and repair.

It is difficult to make any comparison on a cfm per square foot basis, because the average ship air conditioning system delivers only 6000 cfm compared to 30,000 cfm for land systems. In this regard it should be noted that factory assembled air conditioning equipment is seldom used. This is due, to a large degree, to the fact that shipboard systems must be "custom tailored" to suit limited space conditions.

Bulkheads Confine Air Conditioning

The length of a passenger ship is divided into watertight compartments by transverse bulkheads. These bulkheads extend from the bottom of the hull up to the bulkhead deck. The bulkhead deck, incidentally, is not watertight. Several of the watertight compartments can be flooded on a large ship without any danger of sinking. Even a small cargo ship will stay afloat with one compartment open to the sea. The distance between watertight bulkheads is less than that of the main vertical fire zone bulkheads. Maximum allowable spacing of fire zone bulkheads is 131 ft, and there may be two or three watertight compartments within this distance.

Regulations do not allow openings in the watertight bulkheads. Therefore air conditioning systems



TYPICAL SYSTEMS, ZONES for air conditioning a large passenger liner might be as shown above. System No. 1 is for officers' quarters; No. 2, for crew's quarters; No. 3, for passenger staterooms; No. 4, for public space. Note watertight bulkheads, fire zones—both factors in air conditioning design

must be confined to one watertight compartment, unless conditions are such that the bulkheads do not have to extend all the way to the weather deck. This, of course, tends to increase the number of systems, as well as the cost of installation.

While protection of weather terminals is the same on both land and sea, the shipboard installation also must be protected from sea water. This is accomplished in two ways: first, inlets and outlets are located as high as possible above the water; second, special provisions are fitted to keep water out. Air lifts, 180 deg goosenecks, and hoods which require a vertical lift with low air velocities are used. As an additional precaution, drain pipes are connected to plenums and low points to carry off any water which does get into the system. Louvers, when provided, are considered decorative rather than functional.

In order to minimize the unbalancing effect of ship speed, terminals are not located on weather exposed surfaces facing forward. Salt water is very corrosive to steel, and this alone presents sufficient reason for keeping water from entering ship systems. Even where stainless steel is used for working parts, such as pneumatic motor operated dampers, salt deposits can jam clearances, and cause malfunctioning.

Soot carried into the systems also contributes to this corrosion as well as the filtering problem aboard ship. On the other hand, intakes at sidewalk and basement levels presents a problem for a hotel not found on board ship.

Ship Structures Have High Conductivity

A large amount of high conductivity in structural material is common to all ships. In hotels on the other hand, the amount of glass and metal can vary from just normal size windows to all glass and prefabricated metal construction. Except in large public spaces, air ports or windows on ships are less than 6 sq ft in area. In public spaces, the windows are larger, sometimes deck to deck. But these are usually shaded and are seldom exposed to full sunlight.

The steel structure of a ship is a poor insulator against heat transmission. In addition to the flat plates, the angles and T-beams used for stiffening act as fins, providing considerable secondary heat transfer surface. With modern insulating materials and techniques, the solar and transmission loads can be held down to reasonable amounts.

While the overall heat transfer coefficients of the insulated ship's structure are reasonably low, the lack of mass does not afford the lag and associated storage effect of brick and concrete structures. Thus the peak loads are rather high, considering the small glass area involved. Obviously, the prefabricated insulated metal panels used in many modern buildings compare to a large degree with typical ship construction.

Few "Typical" Rooms Aboard Ship

The basic arrangement of guest rooms in a large hotel is about the same for most floors. Thus it lends itself to running ducts and piping mains vertically as risers, with limited horizontal distribution. This similarity also reduces design costs, since there are relatively few different types of rooms.

It should be noted that naval architects strive for duplicate deck arrangements. Nevertheless, there are seldom more than two or three decks with any appreciable similarity of arrangement of staterooms. While port and starboard spaces are frequently identical, there are relatively few "typical" rooms. Therefore load calculations are much more complex.

Space arrangements are such on most ships that each air conditioning system usually serves only one or two decks. Thus the major distribution for piping and duct systems is horizontal. Piping systems, of course, are not confined to fire zones. Another practical reason for horizontal distribution is that piercing of the heavy steel decks is expensive. In many cases, these decks are structural members and cuts in them are limited to certain areas. ∓

How to Apply Direct Fired Heaters

● Direct fired heaters can provide excellent, inexpensive winter space heating and summer air circulation to industrial plants if they are properly applied. Finding the best heater locations to gain adequate coverage of the area to be heated is the major problem. Effective air flow is an important factor in determining the number and location of units to be used to satisfy the heating needs of a particular plant. The author outlines seven points that will aid in finding the best locations, shows how to calculate effective air throw, and explains how ducts and nozzles can be used with these heaters to solve certain air distribution problems.

Mr. Stern is a 1943 mechanical engineering graduate of the Northwestern Technological Institute. Following graduation he served as an engineering officer in the U.S. Navy. After World War II he worked for Underwriters' Laboratories, Inc., and from there went into apprentice training as a field service engineer on industrial heating equipment. He was later employed in engineering research and sales. Before joining Lennox in 1957, Mr. Stern was president of a business which designed, manufactured, and sold large capacity direct fired space heaters.

BY M. H. STERN
Industrial Market Manager
Lennox Industries Inc.

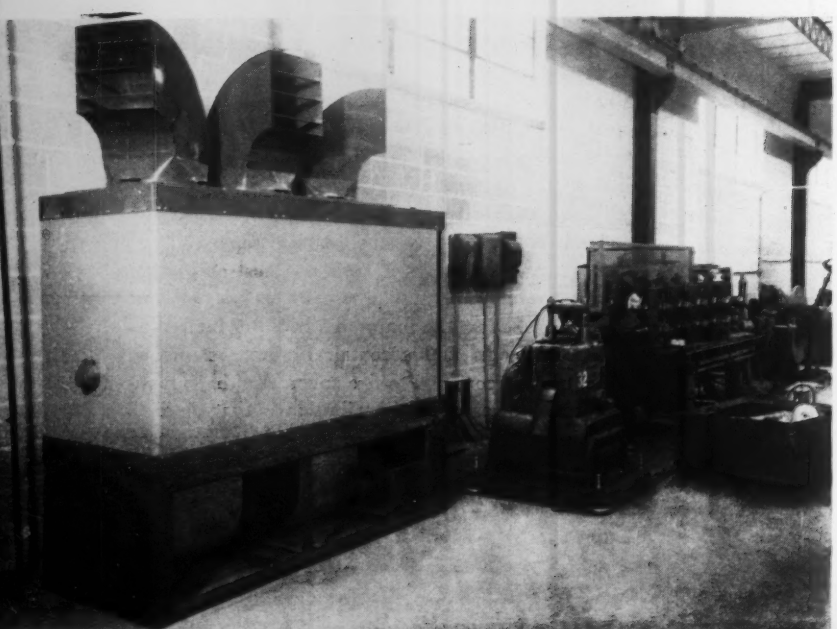
DIRECT FIRED HEATERS transfer the heat of combustion to the heat exchanger and then to air which is delivered directly into the space to be heated. They are generally located in the area to be heated. When on the floor, cool air is drawn into the centrifugal fan at the base of the unit and is then forced up and over the heat exchanger into directional nozzles at the top.

Warm air is discharged horizontally at relatively high velocities of about 2000 fpm. These high velocities permit adequate coverage of large, unobstructed areas without the use of ducts. The advantage of mounting the heaters on the floor as compared with suspended mounting is shown in Figs. 1 and 2.

The following seven points may be used as a guide in determining the best heater locations. Of course, each installation must be studied carefully in order to weigh all the factors before deciding on the location.

1) Floor mounted heaters should be used whenever possible to provide easy access for maintenance.

2) All heaters should be located along outside walls to permit delivery of warm air along outside



TYPICAL INSTALLATION of industrial direct fired heater with discharge air nozzles arranged for floor mounting. Temperature control system on this type of application consists merely of *on-off* thermostat controlling burner operation from room temperature. Return air enters into base of heater at blower compartment, is passed over heat exchanger, is heated and discharged through discharge air nozzles which are rotatable and adjustable so that direction of discharge air can be changed in the field

walls where the heat loss from the building occurs and to permit short outdoor air connections to the unit.

3) If heaters are to be suspended, the maximum distance above the floor should be 12 ft.

4) Large door openings should be blanketed by warm air to offset infiltration of unheated air.

5) Heaters introducing outdoor ventilation or makeup air should be installed as remotely as possible from exhaust fans and hoods to prevent short circuiting.

6) Nozzle extensions should be used if discharge air is obstructed by highly stacked material in the area.

7) Locate heaters to achieve good air distribution without exceeding the air throw capacity of the individual heater.

How to Find Air Throw

Determination of the effective air throw from these heaters is important; this dictates to a large degree the number and location of units to be used to satisfy a particular heating problem. Under normal conditions the effective air throw of a unit is a function of these design features:

1) Size and shape of the discharge air nozzle

2) Final velocity of the air stream to be considered (usually 100 fpm)

3) Quantity of air to be discharged

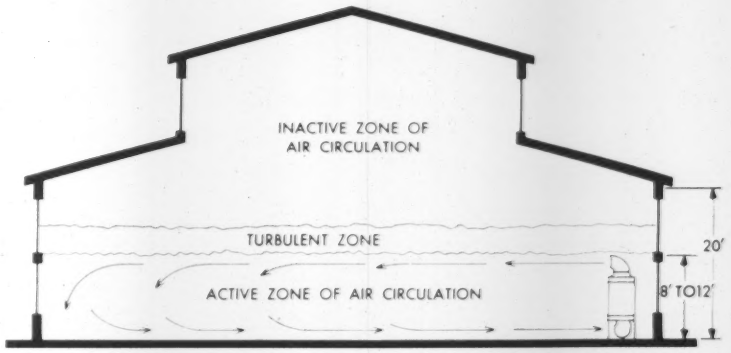
4) Ratio of free area to gross area in the discharge air nozzle

5) Coefficient of discharge.

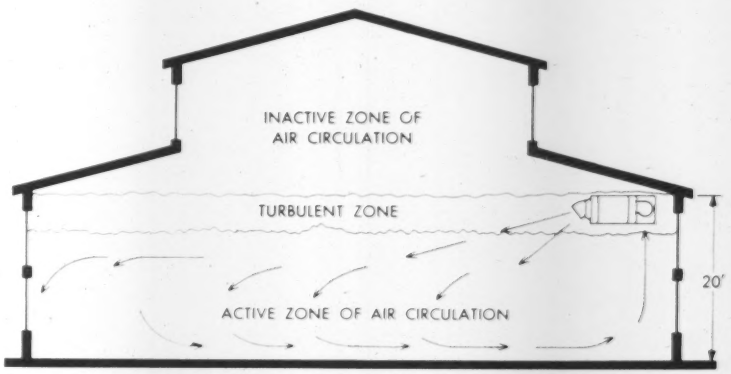
The air throw from a discharge nozzle can be determined from the following equation in which all of the above factors are related:

$$\text{Air throw} = \text{(constant/final velocity)} \times \left[\text{air quantity} \Big/ \left(\sqrt{\text{total free area of outlet/coefficient of discharge}}\right)\right]$$

Air throw data shown in Table 1 has been assembled for a number of conditions using the above equation and based upon the following conditions:



1 FLOOR MOUNTED UNITS provide air circulation at working level. Air volume to be circulated is reduced, resulting in maximum number of air changes per hour in active zone of air circulation. Horizontal suspended heaters mounted at 8 to 12 ft and handling same volume of air will produce comfort comparable to floor mounted heaters



2 SUSPENDED HEATERS located at roof line must handle larger volumes of air in order to provide same number of air changes as floor mounted units

1) Final velocity of 100 fpm

2) Ratio of free area to gross area of nozzle of 0.90

3) Coefficient of discharge of 0.75.

The following examples illustrate how the information given in Table 1 can be used.

● Example No. 1:

The calculated heat loss for Building *A* is 1 million Btu per hr, and the air throw required is 180 ft because of the building shape. From Table 1, note that approximately 13,000 cfm of air must be delivered to obtain the air throw of 180 ft with the required heater of 1 million Btu per hr capacity. Specifications for the heater should show its output capacity, cfm, and fan motor size.

● Example No. 2:

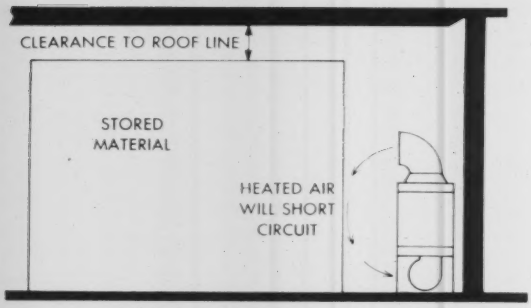
The calculated heat loss for Building *B* is 1 million Btu per hr, and the air throw required is 150 ft because of the building shape. From Table 1, note that only 11,000 cfm of air is required to obtain the desired air throw in this case for the same heater. This will permit the use of a smaller fan motor, reducing the operating cost.

Duct Systems Can Be Used

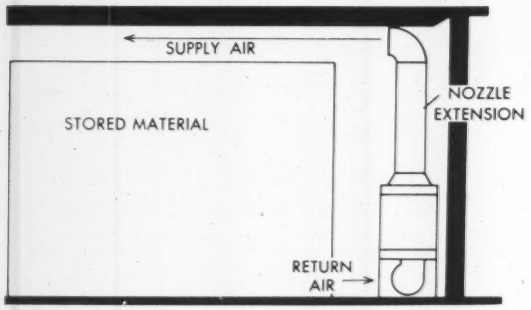
Duct systems can be used with direct fired space heaters and are necessary:

1) When stockpiled material interferes with free discharge of warm air.

2) When there are enclosed areas within the main heated space



3 IF LOCATED TOO CLOSE to stored material, heated air from floor mounted units will short-circuit, creating problem of poor air distribution



4 SIMPLE, INEXPENSIVE solution to distribution problem is to provide air nozzle extensions consisting of relatively short sections of duct

such as small offices, toilet rooms, etc. Office areas that require cleaner conditions should not be heated by a duct run from the same large direct fired heater serving areas devoted to manufacturing. These office areas should have their own heating and temperature control systems.

3) When high outdoor air infiltration rates occur near loading doors.

4) When all areas do not have the same heating requirements.

Use Nozzles, Too

Buildings used for storing materials can present a problem in achieving the proper air distribution from a direct fired heater. The volume of the stored materials often leaves only aisles and limited clearance from the pile to the roof line for circulation of the warm air. Fig. 3 shows what can happen under these conditions.

A simple and inexpensive solution to this problem is to provide air nozzle extensions consisting of relatively short sections of duct, as shown in Fig. 4. Thus, the short circuiting of heated air is eliminated, and the zone of active air circulation is increased.

This condition is not detrimental to the overall heating effect, since close temperature control is not a requirement for structures of this type. Of course, a conventional duct system could be installed which would permit closer control of the temperatures in the heated space and would decrease the volume of the active zone of air circulation. The first cost of such an installation would be greater, but it would naturally be offset somewhat by lower fuel costs resulting from reduced air temperatures below the roof or ceiling.

When free air discharge is not possible, the use of a duct distribution system is a matter of economics. Each case should be considered on its own merits.

In another article, to appear soon, the subjects of controlling the direct fired heater, heating makeup air for industrial ventilation applications, and sizing the fuel piping systems will be discussed. ±

TABLE 1 — AIR THROW DATA, calculated from relationship of air quantity, outlet area, and heater capacity, is tabulated below for heater with 100 fpm final velocity, 0.90 ratio of free area to gross area of nozzle, 0.75 discharge coefficient

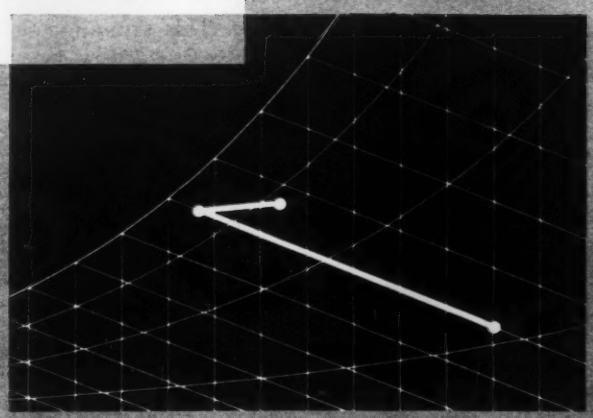
Direct fired heater capacity, Btu per hr	Total outlet area, sq ft	Total air quantity at 70 F, cfm	Effective air throw, ft
400,000	2.9	3,000	59
		4,000	79
		5,000	99
		6,000	119
		7,000	139
500,000	4.4	4,000	64
		5,000	80
		6,000	96
		7,000	112
		8,000	128
		9,000	144
		10,000	160
750,000	5.0	7,000	105
		8,000	120
		9,000	135
		10,000	150
		11,000	165
		12,000	180
		13,000	195
1,000,000	5.4	10,000	142
		11,000	156
		12,000	170
		13,000	184
		14,000	198
		15,000	212
		16,000	226
1,500,000	10.0	12,600	128
		13,000	139
		14,000	150
		15,000	161
		16,000	172
		17,000	183
		18,000	194
		19,000	205
2,000,000	13.6	17,000	156
		18,000	166
		19,000	176
		20,000	186
		21,000	196
		22,000	206
		23,000	216
		24,000	226
		25,000	236

HPAC ENGINEERING DATA FILE

Evaporative Cooling

When and How to Use It

- *How it works*
- *The effects of weather*
- *Comfort relationships*
- *Space cooling design*
- *Industrial relief cooling*
- *Where it is used*



Evaporative Cooling—Potential and Limitations

EVAPORATIVE COOLING — the oldest form of cooling known — is often overlooked as a means of providing suitable summer comfort or a cool air stream for process cooling. Yet this form of cooling, which gave birth to the art of air conditioning, still has many applications. Also, new applications continue to arise as the control of summer conditions is looked upon more as a necessity than a luxury.

There is no question but what evaporative cooling has limitations which are principally related to local wet bulb temperatures and to fields of usage. However, the limitations are often assumed rather than real. This is not meant to imply that this method of cooling can be applied on a national scale for providing what today are considered comfortable conditions for sedentary individuals. It can do this in some areas but not in others. On the other hand, in certain hot industries it can provide much needed relief from extreme summer temperatures in any area of the country.

In addition to its use in cooling human beings, an application of growing importance is in the cooling of animal shelters to increase productivity — more eggs, more efficient conversion of feed, etc. Plants grown under glass benefit from evaporative cooling too. In these applications high humidities are not a problem and, in some cases may be desirable.

The potential and the limitations of evaporative cooling were clearly outlined by the late Walter Fleischer[1] when in 1946, he said:

> "In many warm or hot industries I might say 'complete' satisfaction can be obtained with evaporative cooling. In many places, however, evaporative cooling gives only partial satisfaction. There is a vast field for both refrigerated air conditioning and evaporative cooling, but their designed conditions are different. However, as to their relative first costs or the cost of operation, there can be no possible question as to the favorable position that evaporative cooling holds."

In this report, the fundamentals of evaporative cooling are reviewed. The types of equipment in use, the methods followed in design, and some of the factors to consider when designing for specific applications are presented. These are based upon systems in operation and represent the experience of a number of engineers.

How Evaporative Cooling Works

A dry air stream passing through an evaporative cooling device, where it is brought into intimate contact with water, becomes saturated or nearly saturated with moisture. This saturation of the air stream is brought about by the conversion of sensible heat to latent heat. As a result, the dry bulb temperature of the air is lowered and the dewpoint is raised. When no heat is gained or lost through the enclosure of the saturating device and the spray water is recirculated, the total heat content of the air stream leaving the evaporative cooler is nearly the same as that entering and the process can be considered adiabatic saturation. The total heat content of the air stream is increased a small amount by the heat content of the liquid evaporated. From a practical standpoint, evaporative coolers are adiabatic devices.

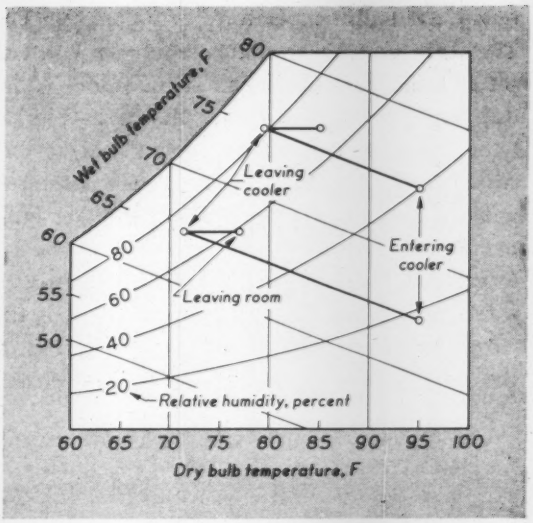
The evaporative cooling process plots on the psychrometric chart as a line parallel to the lines of constant thermodynamic wet bulb temperature. Thus, the entering wet bulb temperature determines the lowest dry bulb temperature at which the air can be supplied. The degree of saturation that is achieved, and thus the reduction in dry bulb temperature, depends on the type of saturating device used. In some jobs, 100 percent saturation of the entering air may be desirable while in others the amount of moisture added to

[1]*Numerals refer to references listed on page 158.*

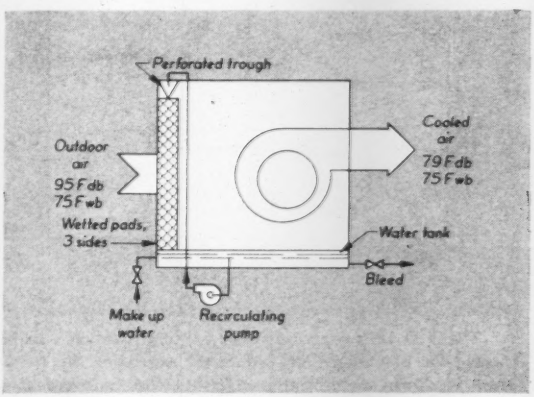
Evaporative cooling is often over-looked as a means of providing a satisfactory indoor environment or a supply of cooled air for process cooling. Yet in many applications — new ones continue to arise — evaporative cooling wisely used and carefully designed may be the best way to provide acceptable conditions.

In some localities, evaporative cooling for human comfort may only provide relief from otherwise warm situations. In others, it may provide complete satisfaction. Comfort cooling applications range from cooling of stores, churches, etc. to relief spot cooling in hot industries, such as metal working plants and laundries. In some of the newer applications, evaporative cooling is used to increase food production through the cooling of animal shelters. Cooling of greenhouses by this means has also been found to improve plant quality and growth.

The fundamentals of evaporative cooling, a look at the effects of weather, comfort conditions related to evaporative cooling, and some points to consider in design are given in this report.



1 DIRECT EVAPORATIVE AIR COOLING process plots on the psychrometric chart as a line parallel to the wet bulb lines. Condition of the air at various points in the evaporative cooling system for two entering wet bulb temperatures shown here are given in Table 1



2 DRIP TYPE EVAPORATIVE COOLER is one of several types used to cool air by process of Fig. 1. Simple perforated trough or pipe wets evaporative pads, which are usually made of aspen wood excelsior. Air drawn through pads is saturated and cooled

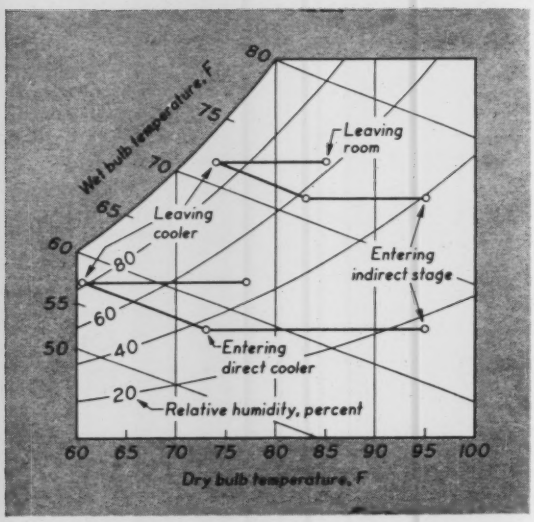
the air may be limited intentionally to best serve design requirements.

The sensible cooling effect that can be achieved by the evaporation of water can be used in a number of ways to reduce the temperature of an air stream so that it is suitable for use as a cooling medium. It may be used directly by evaporating the moisture in the supply air stream, or it may be used indirectly by evaporating the moisture in a secondary air stream which through suitable heat exchangers is used to cool the supply air. Combinations of these two general methods may be used in series to reduce the dry bulb temperature of the supply air to a value lower than the entering wet bulb temperature.

Direct Evaporative Cooling

In Fig. 1, the condition line for direct evaporative cooling is plotted on the psychrometric chart for outdoor air entering the cooler at one dry bulb temperature (95 F) but two dif-

ferent wet bulb temperatures (65 F and 75 F). The air is brought into intimate contact with water by a number of different methods, one is the drip type evaporative cooler shown in Fig. 2. Other types of evaporative coolers will be discussed later. The air tends to become saturated and the process is plotted along the wet bulb temperature line corresponding to that of the entering air. The leaving dry bulb temperature is a function of the saturating effectiveness of the particular device used. In the examples of Fig. 1, the effectiveness is assumed to be 80 percent.



3 TWO-STAGE evaporative air cooling involves sensible cooling in first stage and adiabatic saturation in second stage as shown on plot above. Indirect use of evaporative cooling in first stage permits delivery of supply air at wet bulb temperature below that of entering air

The saturating effectiveness — sometimes called evaporative cooling efficiency — is the ratio of the reduction in dry bulb temperature to the wet bulb depression of the entering air, and it is defined by the following formula[2] from the ASHAE Guide:

$$E = (t_1 - t_2)/(t_1 - t_{wb})$$

where:

E = saturating effectiveness (usually expressed in percent)

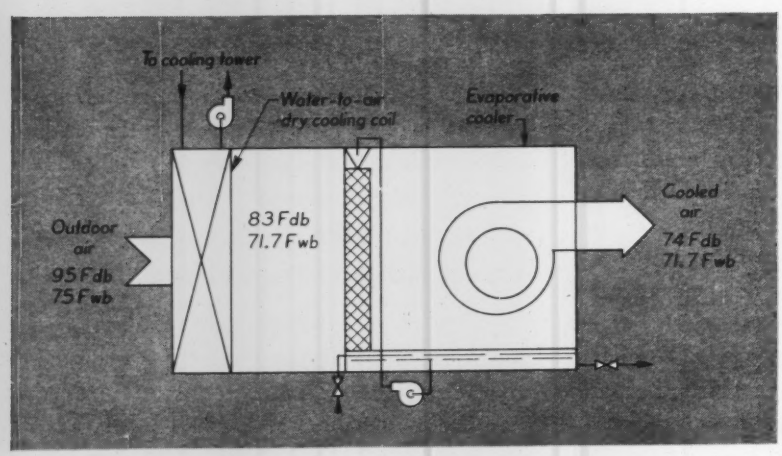
t_1 = dry bulb temperature of air entering saturator, F

t_2 = dry bulb temperature of air leaving saturator, F

t_{wb} = wet bulb temperature of air entering (and leaving) saturator, F

It is evident that a cooler with an effectiveness of 100 percent would supply saturated air at a dry bulb temperature equal to the entering wet bulb temperature.

The condition of the air leaving the cooled space will depend upon the cooling load, the quantity of air delivered by the cooler, and the dry bulb temperature at the cooler outlet. Or, if certain design temperature conditions are to be met to produce satisfactory results, the air flow rate is determined from the sensible cooling load and the allowable temperature rise of the supply air in the space. A 6 F rise has arbitrarily been assumed for the conditions of Fig. 1. This results in a room temperature of 85 F with 75 F wet bulb temperature air entering the cooler and a room temperature of 77 F with an entering wet bulb temperature of 65 F. The air flow rate per ton of sensible cooling load is 1900 and 1755



4 COOLING TOWER and water-to-air heat exchanger followed by direct evaporative cooler is one two-stage system that cools by process shown in Fig. 3

Table 1 — CONDITION of air at various points in direct and two-stage evaporative cooling is given here for the two outdoor design wet bulb temperatures and other conditions shown in Figs. 1 and 3

Item	Direct evaporative cooling		Two-stage evaporative cooling	
Entering system				
1) Outdoor dry bulb, F	95	95	95	95
2) Outdoor wet bulb, F	75	65	75	65
3)* Humidity ratio, lb H_2O per lb dry air (da)	0.01411	0.00634	0.01411	0.00634
4)* Heat content, Btu per lb da	38.38	29.80	38.38	29.80
Leaving dry cooling coil				
5) Dry bulb, F	—	—	83	73
6) Wet bulb, F	—	—	71.7	57.2
7)* Humidity ratio, lb H_2O per lb da	—	—	0.01411	0.00634
8)* Heat content, Btu per hr lb da	—	—	35.48	24.48
Leaving evaporative cooler with effectiveness = 80 percent				
9) Dry bulb, F	79	71	74	60.4
10) Wet bulb, F	75	65	71.7	57.2
11)* Humidity ratio, lb H_2O per lb da	0.01785	0.01185	0.01619	0.00923
12)* Relative humidity, percent	83	72	90	82
13)* Heat content, Btu per lb da	38.55	30.00	35.55	24.60
14)* Specific volume, cu ft per lb da	14.0	13.6	13.9	13.3
Leaving cooled space with SHR = 1.0				
15) Dry bulb, F	85	77	85	77
16) Wet bulb, F	76.5	67	74.7	63.1
17)* Humidity ratio, lb H_2O per lb da	0.01785	0.01185	0.01619	0.00923
18)* Relative humidity, percent	68	60	63	47
19)* Heat content, Btu per lb da	40.02	31.55	38.20	28.59
20) Effective temperature at:				
velocity of 150 fpm, F	79.5	70.5	78.0	69.5
velocity of 300 fpm, F	77.0	69.5	76.0	68.5
21) Volume of air per ton of sensible cooling, cfm	1900	1755	1050	665
22) Water evaporated in direct stage, lb per ton per hr	30.5	42.7	9.5	8.7
23) Water recirculated in dry cooling stage, gpm per ton	—	—	6.6	7.9

Notes:
* Indicates values determined from psychrometric chart
Item 5 — assumed 1st stage can cool air to 8 F above wet bulb, based on 4 F temperature rise in water in coil and 4 F approach in tower
Item 9 = (Item 1) — 0.80 [(Item 1) — (Item 2 or Item 5)]
Item 15 is assumed control temperature
Item 20 from ASHAE *Guide*, Chapter 6
Item 21 = [(200 Btu per min) × (Item 14)] / [(Item 19) — (Item 13)]
Item 22 = 60 x (Item 21) × [(Item 11) — (Item 3)] / (Item 14)
Item 23 = (Item 21) × [(Item 4) — (Item 8)] / [(Item 14) × (△t in coil) × (8.33 lb per gal)]

cfm, respectively. It is evident that the air flow rates are higher with evaporative cooling than they are with refrigerated air conditioning. Additionally, the leaving conditions suggest some limitations of direct evaporative coolers in areas of high design wet bulb temperatures. The higher temperatures and humidities in such areas are offset in part by increased room air motion — a factor that will be discussed later. The internal latent load does not enter into the sizing of the evaporative cooling device because no dehumidification is accomplished. Furthermore, the evaporative cooling system uses 100 percent outside air.

Two Stage Cooling

The condition line for a two stage evaporative cooling process is charted on the psychrometric chart of Fig. 3 for the same two entering conditions of Fig. 1. In the indirect stage, it is assumed that a cooling tower and a dry extended surface coil can reduce the temperature of the supply air from outdoors to within 8 F of the outdoor wet bulb temperature. This reduction requires an 8-row coil operated in counterflow and clean heat exchange surfaces. Fouling of the surfaces and the use of coils with fewer rows will result in smaller reductions. In this first stage, the evaporative cooling effect is used to cool water circulated through the coil in the supply air stream (See Fig. 4). The supply air at reduced dry and wet bulb temperatures is then taken through a direct evaporative cooler having a saturating effectiveness of 80 percent, in this example. The condition of the air leaving the saturator is much lower in each case than those for the corresponding entering temperatures in the previous example. Assuming that the dry bulb temperature of the air leaving the cooled space will be the same as that in the preceding example, 85 F with the high entering wet bulb temperature and 77 F with the low entering wet bulb temperature, the air flow rate for each ton of sensible cooling is reduced appreciably. The air flow rates required are 1050 and 665 cfm, for the high and low wet bulb conditions, respectively. This is in contrast with the 1900 and 1755

cfm in the case of direct cooling. The dewpoint temperature and, consequently, the relative humidity in the space are lower in both cases. This improvement in leaving conditions and the reduced air flow rate are achieved at the expense of the additional equipment — cooling tower, coil, and piping system — required to accomplish the first stage of cooling. Additional stages of indirect cooling could be added to cool the supply air stream to approximately the dewpoint temperature of the outdoor air. However, diminishing returns are achieved in succeeding stages. In most cases, one indirect and one direct stage is all that will be found economically feasible.

A summary of the conditions in the above examples and the formulas used to calculate the several variables are given in Table 1. The properties of the moist air mixtures have in this case been taken from the psychrometric chart, but if more precision is needed they can be computed from tables[3] of the thermodynamic properties of moist air.

In determining the condition of the air leaving the room in Figs. 1 and 3, it was assumed that the space sensible heat ratio was 1 or that there was very little internal latent heat gain. This is often the case, but where processes release large quantities of moisture, this must be taken into account when determining the condition of the air leaving the cooled space. It should be noted that water vapor will tend to migrate out of the conditioned space rather than into it as is the case when low relative humidities and corresponding low vapor pressures are maintained in the conditioned space. Thus, only the internal latent heat gains must be considered and then only for the purposes of determining the conditions that will exist in the space. For sizing the evaporative cooling device and determining the required air flow rate, only the sensible load must be computed. The heat gain is estimated in the same way that the load for refrigerated air conditioning is computed, taking into consideration the dry bulb temperature that can be maintained.

Weather — The Index of Applicability

Knowledge of local wet and dry bulb temperatures is a must in the application of evaporative cooling. Knowing the maximum values of each or the commonly accepted design values is not sufficient for the purposes of designing an evaporative cooling system. Coincident values of these temperatures and the number of hours that any given wet or dry bulb temperature will be exceeded in a statistically normal summer are indispensable. These will permit a rational analysis of the conditions that can be maintained by evaporative cooling and the duration of unsatisfactory conditions that may exist when design conditions are exceeded.

The recently published book,[4] *Evaluated Weather Data For Cooling Equipment* provides much useful data for the design of the evaporative cooling system. Frequency of occurrence of wet bulb temperatures are given for a large number of cities based upon a statistical analysis of hourly weather records for the four summer months, June through September, covering the 10 year period from 1948 through 1957. Coincident wet and dry bulb temperatures are given for 49 representative localities. The total number of hours in the four month period analyzed is 2928.

Some values of wet bulb temperature frequency levels are given in Table 2 for selected cities. A frequency of 1 percent indicates that the tabulated wet bulb will be *equalled* or *exceeded* only about 30 hours during the normal season. A 5 percent level corresponds to 150 hours and 15 percent indicates 450 hours at or above the given wet bulb temperature.

The cities have been listed in order of increasing wet bulb temperature at the 1 percent frequency level. The list can be divided generally into broad geographic areas with the lowest values occurring in part of the southwest, mid range in the plains states and part of the east coast, and the high values in the southeast. Parts of the southwest, Phoenix and Tucson for example, have wet bulb temperatures in the high and middle 70's on the 1 percent level

Table 2 — WET BULB TEMPERATURES at several frequency levels for selected* cities during four summer months, June through September, arranged in order of increasing wet bulb temperature equalled or exceeded only 30 hours per year are given here

City	Wet bulb temperature, F, at specific frequency levels†			High coincident design temperatures, F	
	1%	5%	15%	Dry bulb	Wet bulb
Albuquerque, N.M.	66.3	64.8	62.9	94	66
Salt Lake City, Utah	66.9	64.4	61.7	95	66
El Paso, Tex.	69.7	68.0	63.6	97	69
Tucson, Ariz.	72.9	71.4	69.8	100	72
Fresno, Calif.	73.2	70.5	67.5	103	72
Detroit, Mich.	76.4	73.6	70.4	92	76
Phoenix, Ariz.	76.8	75.3	73.4	106	76
New York City	77	74.9	72.2	92	76
Huron, S. D.	77.2	73.9	70.0	96	77
Chicago, Ill.	77.7	74.8	71.5	94	77
Charlotte, N. C.	77.7	76.0	74.2	96	77
St. Louis, Mo.	79.0	76.8	74.3	97	78
Memphis, Tenn.	80.4	78.6	76.5	98	80

*Abstracted from *Evaluated Weather Data For Cooling Equipment*,[4] courtesy of Fluor Products Company, a Division of Fluor Corporation, Ltd.
†Percent of hours in season of 2928 hours during which listed wet bulb temperature is equalled or exceeded.

which are comparable to those in the midwest. It is interesting to note that a listing on the 5 percent or the 15 percent level would place Phoenix at the high wet bulb end of the list. It has higher wet bulb temperatures at these levels than most cities in the upper midwest. Thus, while the evaporative cooler is usually considered acceptable for the "hot, dry southwest," some of the cities in which it is used in this area have relatively high design wet bulb temperatures.

Coincident wet and dry bulb temperatures that are *exceeded* only 1 percent of the time or 30 hours during the normal season are also listed in the table for the same cities. Other values are given in Reference 4 for lower design conditions which are, of course, exceeded during a greater number of hours each season. The time that an evaporative cooler may fail to live up to expectations can be estimated from the coincident values.

No attempt is made here to establish the areas in which evaporative cooling will and will not work with success. As noted earlier, for comfort cooling of sedentary individuals there are regions in which evaporative cooling would not be successful. In Memphis, Tenn., for example, with wet bulb temperatures exceeding 78 F five percent of the time, evaporative space cooling would produce partial satisfaction only part of the time and complete satisfaction only on rare occasions. However, in hot industry applications it can provide relief cooling. Each locality and each application should be considered in relation to what is expected and required of the system, whether it is to be an interim solution to a cooling problem, if only spot cooling is needed, and what economic limitations are placed on the system. If this is done, it will be found that evaporative cooling can be an effective tool in areas other than the "southwest." From this standpoint, the line of demarcation between areas suitable for evaporative cooling and those that are not suitable is not very sharp and perhaps is nonexistent.

Evaporative Cooling and Comfort

In evaluating whether evaporative cooling can be used in a particular situation, the comfort level of the room conditions that can be maintained must be determined. Some difficulty is experienced in relating the environmental factors of dry bulb temperature, wet bulb temperature or relative humidity, room air motion, and mean radiant temperature or the average temperature of the enclosing surfaces on individual comfort. At present the ASHAE effective temperature is the only index available[5] for correlating the first three of these variables to determine environments of equal comfort or equal discomfort. Dr. Bedford[6] has modified the effective temperature chart to include the effects of mean radiant temperature as indicated by a globe thermometer. Thus, his chart takes into account all four of the factors of concern in any comfort cooling installation.

Comfort of Slightly Active Persons

It is generally agreed that the comfort chart is in need of revision due to the limitations imposed upon it by the test conditions on which it is based and changes that have occurred in stand-

ard of living, dress, etc. Recent studies[7] show that for dry bulb temperatures below 80 F, effective temperature over-emphasizes the effects of relative humidity, while above this temperature, effective temperature more nearly represents the effects of relative humidity. Based upon these same studies, the conditions at which most sedentary people are comfortable fall within a dry bulb temperature range from 73 to 77 F, and relative humidities from 25 to 60 percent when room air velocities do not exceed 25 to 35 fpm. These limits also take into account in a qualitative way the effects of mean radiant temperature. The upper limits of dry bulb temperature and relative humidity correspond to an effective temperature of about 73 F.

Air Motion Is Important

Other conditions of dry bulb temperature, wet bulb temperature, and air velocity that will produce the same effective temperature can be obtained from the comfort chart. Selected combinations of these variables corresponding to an effective temperature of 73 F are given in Table 3. The significant thing to note is that the room air motion must increase appreciably as the wet and dry bulb temperatures are increased to maintain this level of effective temperature. The fact that increased air motion can compensate for higher levels of wet and dry bulb temperature is of importance and is one of the principal reasons that evaporative cooling can be used effectively for cooling sedentary individuals in localities having moderate wet bulb temperatures. The extent to which the velocity can be increased without causing undue discomfort when applied to space cooling is not known. In some hot industry applications, target velocities (the velocity of the air impinging upon the worker) in excess of 300 fpm have been used with success. However, for sedentary individuals, this velocity may be too high for comfort so that high space temperatures cannot always be offset by increased air motion. Furthermore, the results of recent studies[8] suggest that room air velocities of 120 fpm produce the maximum benefit at high temperatures and high humidities for sedentary subjects. Velocities of 200 and 300 fpm were checked in these studies and only slight improvements in comfort of the subjects were observed.

Table 3 — ROOM CONDITIONS providing effective temperature of 73 F based upon ASHAE Effective Temperature Chart

Temperature, F		Relative humidity, Percent	Room air velocity, fpm
Dry bulb	Wet bulb		
77	67	60	less than 20
80	64.3	43	less than 20
80	70	61	170
80	75	80	320
85	58	16	less than 20
85	65	33	260
85	70	48	480

Limiting Effective Temperature

If some periods of discomfort or less than satisfactory conditions can be tolerated, a higher design effective temperature can be selected. The upper limit of effective temperature that provides relief from sensible perspiration has been determined to be about 78 F. While most sedentary people would judge environments at this temperature as being uncomfortably warm, moderately active, standing persons judge[1] such conditions as comfortable or comfortably warm. It is also reasoned by some that this is a more desirable condition than the higher effective temperature of the outdoor air. In such cases, evaporative cooling could be considered as an interim or relief cooling measure until a change in economics of the situation permitted installation of a refrigerated air conditioning system that would provide completely satisfactory conditions. A higher design effective temperature would allow lower room air velocities or permit the application of evaporative cooling in areas of higher wet bulb temperature. It must be recognized that the conditions maintained would not be satisfactory 100 percent of the time nor for 100 percent of the people involved but would provide some relief.

The need for high room air motion is a departure from the design of refrigerated air conditioning that should be noted. In contrast with the design effort expended to introduce the conditioned air to maintain minimum air motion, the evaporative cooling design effort in areas of high design wet bulb temperatures must be di-

Table 4 — HEAT STRESS INDEXES computed from Belding and Hatch data for an assumed industrial spot cooling problem, for ventilation with outdoor air and with outdoor air evaporatively cooled, shows improvements that can be made with evaporative cooling

Mean temperature of surroundings, F	Globe thermometer reading, F	Supply air temperatures, F		Velocity of air on worker, fpm	Heat Stress Index	Comment
		Dry bulb	Wet bulb			
106	100	95	75	100	82	Very severe strain, only small percent of workers qualified for work
106	99	95	75	300	60	Severe heat strain, some decrease in performance, not suitable where mental effort is required
106	97.5	95	75	600	50	Same as for HSI 60 above but not as severe
106	93	85	76.5	100	65	Severe to very severe strain, see notes above
106	91	85	76.5	300	37	Moderate to severe strain, some decrease in performance in physical jobs expected
106	89.5	85	76.5	600	28	Mild to moderate strain, subtle decrease in performance in jobs involving higher intellectual functions

rected to inducing relatively high air motion. Fortunately, the large air volumes required work to advantage in this respect. As noted above, the air velocities required for evaporative space cooling will depend upon room conditions that can be maintained. These in turn are a direct function of local weather. Thus, in areas of low wet bulb temperatures (65 to 70 F) the same room air velocities may be desirable for evaporative cooling systems as are used for refrigerated air conditioning.

Evaluate Hot Industry Relief Cooling

The foregoing statements apply to the use of evaporative cooling for providing satisfactory summer conditions for sedentary or slightly active individuals. In hot industrial applications, the effective temperature is not applicable since the heat production of the individual is greater. The Belding and Hatch[9] heat stress index affords one means of evaluating the effectiveness of evaporative cooling in providing relief cooling to minimize heat strains in hot areas. The improvement that can be made with evaporative cooling is indicated by the following example.

Assume a plant located where the design wet and dry bulb temperatures are 75 and 95 F, respectively. The mean temperature of the solid surroundings is assumed to be about 105 F. The workers are standing and doing moderate work at a machine or bench so their metabolism is about 1000 Btu per hr. To determine the merit of evaporative cooling assume that a ventilation system is provided so that in one case outdoor air at 95 F (assuming no temperature rise in the air for simplicity) is directed on the worker. The wet bulb temperature of this air is 75 F. Evaporative cooling having a saturating effectiveness of 80 percent is then added. The condition of the air leaving the evaporative cooling device will be 79 F dry bulb temperature and 75 F wet bulb temperature. In this case assume that an air temperature rise of 6 F takes place before the air impinges upon the worker. The wet and dry bulb temperatures of the air will then be 76.5 F and 85 F, respectively. The Belding and Hatch heat stress index for these temperature conditions and for several air velocities is given in Table 4. Comparing the heat stress indexes at the highest velocity considered (600 fpm) shows the improvement made with evaporative cooling. With no cooling, and a velocity of 600 fpm the heat stress index is 50 which is defined as a severe heat strain. With evaporative cooling, the heat stress index is 28 which is indicative of a mild to moderate heat strain that results in only subtle decreases in performance. This is a hypothetical case but indicates the gains that might be expected from a practical application of evaporative cooling. As in the case of space cooling, each job must be considered individually to determine the benefits that will be gained and whether the use of evaporative cooling is feasible. The heat stress index offers the possibility of evaluating the benefits.

Evaporative Devices of Many Types Used

A number of different evaporative devices are used for cooling purposes. These range from the unit type evaporative coolers designed and constructed for relatively small air flow rates and capacities to the large air washers of various types that may be considered as the central system evaporative cooler. The principal differences are in the means by which the air stream is saturated. Unit evaporative coolers consist basically of a porous pad or pads through which air is drawn, a means of keeping the pad saturated, and an air moving device to draw air through the cooler and deliver it to the conditioned space.

Drip Coolers

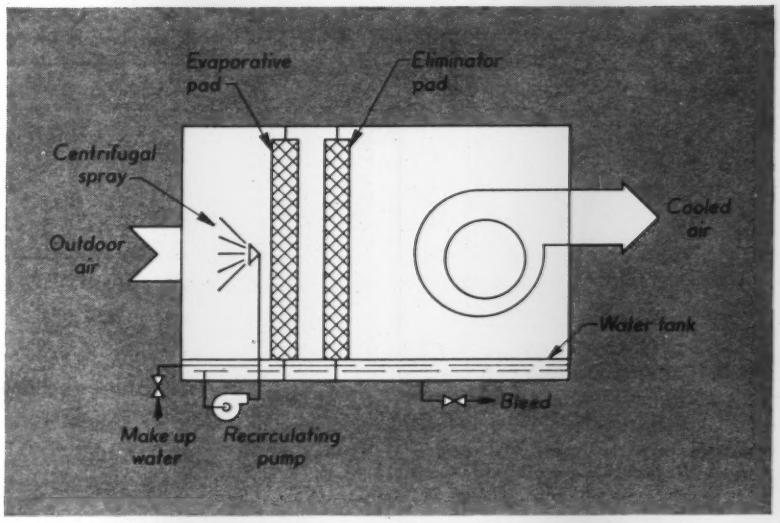
One of the most common evaporative coolers is the so called drip type illustrated in Fig. 2. The pads in these are usually made of aspen wood excelsior and make up three sides of the fan enclosure. Water is delivered to a perforated trough or pipe above the pads and drains by gravity through the pads to saturate them. Excess water not evaporated in the pads drains to a sump. From here the water is returned to the troughs by means of a small pump or it is drained to waste. The water distribution piping insures equal water flow to each trough. The saturating effectiveness of the drip cooler depends upon the distribution of the excelsior in the pads and the uniformity of water flow over the pads. Voids in the excelsior must be eliminated for best results. The saturating effectiveness of the drip cooler is about 75 to 80 percent with 110 F air entering the cooler and relative humidities from 12 to 23 percent according to recently reported[10] studies. The effectiveness decreases slightly with increases in the relative humidity of the air entering the cooler. Drip coolers are made with capacities up to 20,000 cfm for industrial and commercial applications. In large systems they are used in multiple. Since the wetted pads are relatively efficient filters, these and all wetted pad coolers should be located away from sources of excessive dust which could plug the pad in a short time and reduce the system air flow rate. Some water carryover may occur in these coolers and cause corrosion[11] of the fan and other metal parts.

Air Washer Coolers

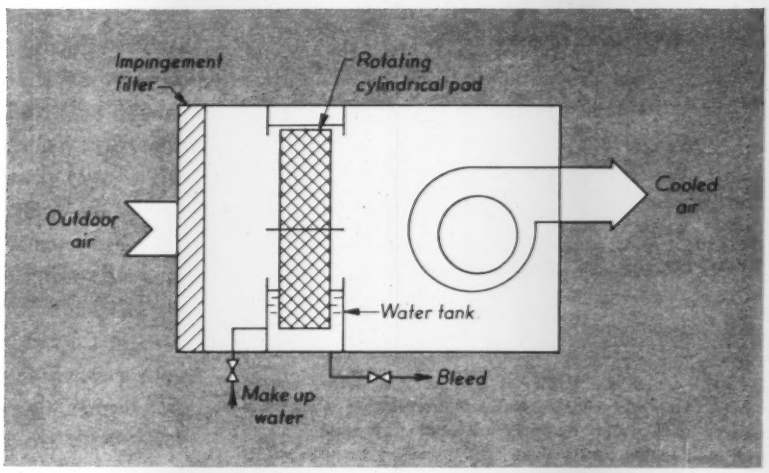
A single evaporative pad is used in the spray type or air washer evaporative cooler shown in Fig. 5. Water is sprayed into the incoming air stream from a centrifugal spray nozzle near the center of the pad, or lifted into the air stream from the collecting tank by a "slinger" located in front of the pad. Thus, the incoming air stream is prewashed and partially saturated before passing through the pad. The spray impinges[12] upon the pad thereby washing it of dust and dirt not removed from the air by the spray water. A second set of pads is often located between the blower and the wetted pad to remove entrained moisture. The pads in the spray or slinger cooler are usually made of aspen wood or glass fiber. The saturating effectiveness of these coolers depends upon uniformity of water distribution from the spray or slinger. Spray coolers of this type have an efficiency of 90 percent or higher. The "slinger" type is apt to be less efficient and the results of the studies[10] mentioned above indicate an effectiveness for this type cooler of 60 to 65 percent which does not change appreciably with changes in relative humidity. The low effectiveness was due to failure of the slinger to wet all areas of the pad. The air washer cooler is made in capacities ranging from 3000 to 12,000 cfm.

Rotary Coolers

A third type of wetted pad cooler utilizes a rotating pad which is partially immersed in a water tank, as illustrated in Fig. 6. The disk like pad, which is made of alternate layers of crimped and flat copper or bronze screen, is thoroughly saturated as it rotates through the water. To prevent plugging of the metal pad, the air is prefiltered with washable impingement type filters. Control of scaling — an important



5 AIR WASHER evaporative cooler employs spray as shown here, or a "slinger" to contact water and incoming air stream. First pad further saturates air, second pad removes entrained moisture

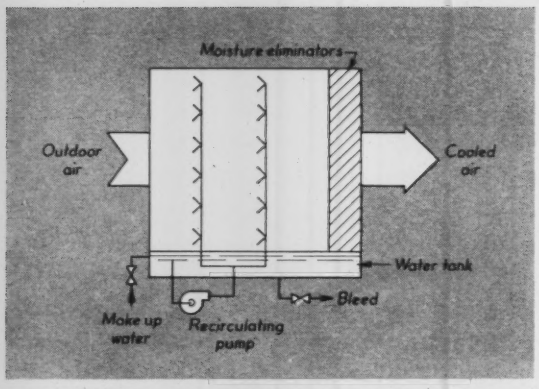


6 ROTARY COOLER exposes large wetted surface to air through use of rotating metal mesh pad partially immersed in water

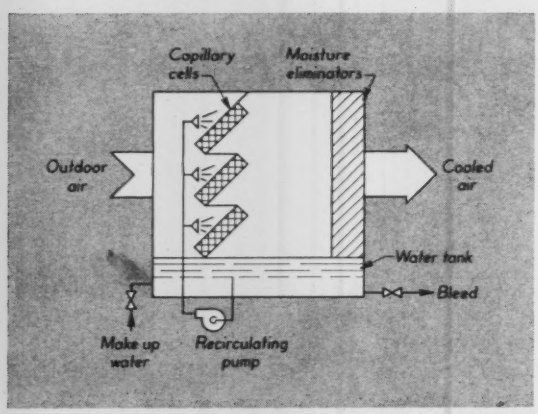
factor in maintaining saturating effectiveness in all evaporative devices using hard waters — is very important in the rotary type because of the fine mesh screen used. These coolers are equipped with a built-in intermittent water flush device to control scaling. The saturating effectiveness of the rotary cooler is 90 percent and above. In the studies[10] mentioned earlier, the saturating effectiveness of the rotary cooler ranged from 85 to 95 percent. The higher value again being recorded at low relative humidity. Rotary coolers are made in capacities ranging from 2500 to 8000 cfm. The evaporating section can be used in parallel with others in a central fan system for higher capacity. Since the pad carries little excess water, moisture entrainment is minimized.

Commercial Air Washers

The commercial air washer has been used for humidifying, dehumidifying, cooling, cleaning, and purifying air streams for many years. To accomplish these functions, it utilizes the same principle of water atomization as the spray type evaporative cooler. It consists of a system of water sprays, a tank for collecting water falling



7 COMMERCIAL SPRAY WASHER is used as central station evaporative cooler. Arrangement and number of sprays determine saturating efficiency. They are often used where both cleaned and cooled air are desired



8 FILL-TYPE air washer is also used as central station cooler. Air-water contact is made in cells of glass fiber sprayed with water. Requires use of smaller water quantities and pump heads than spray washer for equivalent amount of evaporative cooling. Carry over of entrained moisture is also minimized

from the sprays, moisture eliminators in the outlet, and a suitable enclosure (See Fig. 7). Louvers may be used at the inlet when needed to insure uniform air flow through the washer.

Intimate contact of air and water is obtained in several ways. A bank or banks of spray nozzles which atomize the water, flooded baffles, or a combination of the two may be used for this purpose. The saturating effectiveness of an air washer depends[13] upon:

1) Air velocity through the washer.
2) Water to air ratio in the spray chamber.
3) Spray nozzle design and pressure, which determine the degree or fineness of atomization.
4) Number of spray banks and arrangement of nozzles.
5) Entering air dry bulb and wet bulb temperatures.

Table 5 — SATURATING EFFECTIVENESS or efficiency of air washers (when used as evaporative coolers)

No. of spray banks	Direction of water spray	Length of washer, ft	Percent efficiency or saturating effectiveness
1	With air flow	4	50 to 60
1	With air flow	6	60 to 75
1	Against air flow	6	65 to 80
2	With air flow	8 to 10	80 to 90
2	Opposing each other	8 to 10	85 to 95
2	Against air flow	8 to 10	90 to 98

From article "How Air Washers Perform When Cooling," by H. M. Hendrickson.[13]

Washer air velocities normally[13] range from 400 to 650 fpm, with 450 to 550 fpm recommended unless severe space limitations make the higher velocities necessary. Spray carryover may occur with the higher air velocities, so they should be avoided in comfort cooling applications. Spray nozzle pressures vary from 15 to 35 psi with 25 psi about average. Water quantities from 2 to 5 gpm per sq ft of face area per spray bank are usually used in the air washer. However, saturating effectiveness or evaporative cooling efficiency is not materially improved[13] if the amount of water sprayed is increased beyond 2 gpm per sq ft of face area per spray bank. Oftentimes, large air quantities and a single spray bank are preferred to lower air quantities and a double spray bank washer. This limits the increase in dewpoint or relative humidity because of lower saturating effectiveness. The saturating effectiveness for various spray arrangements is given in Table 5.

Commercial air washers are available in a wide range of capacities up to several hundred thousand cfm. Provisions for heating coils may be included in the enclosure making them particularly suitable for combined industrial heating and relief cooling installations. Saturating effectiveness can be varied by design over a wide range as indicated in Table 5.

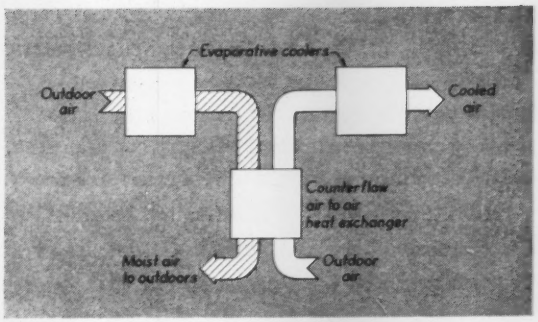
Fill-type Air Washer

The fill-type air washer differs from the

spray washer in that it does not rely upon the atomization of water for contact between air and water. It contains a bank of glass fiber pads or cells upon which water is sprayed to saturate the incoming air stream (See Fig. 8). Due to the large wetted surface exposed to the air by this means, the fill-type washer requires recirculation of a much smaller quantity of water at a lower pressure than the spray washer to do the same evaporative cooling job. The saturating effectiveness of the fill-type air washer is high — it approaches 100 percent — because of the large area of wetted surface exposed to the air stream. As in the case of other coolers using wetted pads, control of scaling is essential to efficient operation when used for evaporative cooling.

Multi-Stage Evaporative Cooling

Mention was made earlier of the use of multiple stages of cooling to reduce the wet bulb temperature of the air delivered from evaporative systems and to increase their overall effectiveness. In the example, used earlier, which is illustrated in Fig. 4, a cooling tower and a water-to-air heat exchanger were used as the first stage for dry cooling the air stream which was then cooled further by direct evaporative cooling. Another type of stage cooling utilizes[14] two air washers and an air-to-air heat exchanger. Outdoor air is evaporatively cooled in the first air washer and passed through the air-to-air heat exchanger. This cool moist air is used to cool a second stream of outdoor air in counter flow and is then discharged to the atmosphere. The air flow arrangement is shown in Fig. 9. The dry cooled outdoor air is then taken through the second air washer, adiabatically cooled, and delivered to the conditioned space. This type of stage cooling requires greater heat transfer surface because of the lower rate of heat transfer in air-to-air heat exchange. As a result, the dry cooling stage is designed[14] for a 12 F approach to the moist air temperature rather than an 8 F approach to the entering wet bulb temperature and higher room conditions result for the same total air flow rate. In regions of high wet bulb temperature, little would be gained by using this system.



9 TWO-STAGE cooler may also use two evaporative cooling units and an air-to-air heat exchanger as shown above rather than a cooling tower-coil-evaporative cooler system shown in Fig. 4. Air streams from two evaporative coolers do not mix

Evaporative Cooling System Design

In the preceding discussion, differences in space cooling for the comfort of sedentary individuals and relief cooling in hot industries have been noted. Some differences in design and application of evaporative cooling must also be considered. In either case, 100 percent outdoor air is taken through the saturator and no room air is recirculated.

Evaporative Space Cooling

The use of evaporative cooling for conditioning entire spaces such as stores, small office buildings, churches, etc. is limited to a great extent by local weather — principally wet bulb temperature. As noted earlier, a history of the wet and dry bulb temperatures of the locality are indispensable for determining the feasibility of using evaporative cooling for such applications. From this history, a design wet bulb temperature can be selected. Where records are not available, References 4 and 15 will provide useful data. Once the design wet bulb temperature is known, an estimate of the condition of the air leaving

the evaporative cooling device can be made based upon an assumed saturating effectiveness. Tentative room design conditions can then be established. Selection of the temperature of the air leaving the cooled space should consider that relative humidity should not exceed 60 to 70 percent, that a suitable effective temperature can be maintained within limits discussed above at reasonable room air velocities, and that the required air flow rate will not be excessive. The latter depends upon the sensible heat gain — determined by usual procedures and is governed to some extent by the recommended relative humidity.

The air flow rate and saturating effectiveness establish the capacity of the evaporative cooling device. A central air washer system may be selected or, in some cases, multiple unit coolers properly located may provide the best solution. If a single unit is selected, the necessary air distribution system is designed by accepted procedures.[16] Since large air volumes must be handled, attention must be given to controlling the noise generated in the duct system. Velocities often exceed limits in the *Guide*. Selection of highest velocities consistent with good practice is desirable to reduce the temperature rise of the air in the ducts and to reduce duct sizes. The supply outlets are selected to provide uniform air motion at the level established by the design conditions. The increased air quantity at higher design wet bulb temperatures works to advantage in providing air motion at the levels required.

Provide Adequate Exhaust

A most important consideration in the design of any evaporative cooling system is making provision for exhausting the same quantity of air as that delivered by the evaporative cooling device.

Table 6 — AIR CHANGE RATES that have been found to provide acceptable results with evaporative cooling are given here for various values of wet bulb depression

Time required per air change, min.	Approximate wet bulb depression, F
3	31-35
2	25-30
1½	20-25

Unless this is done the air flow rate will be reduced and the relative humidity in the space will rise to uncomfortable levels. Exhaust may be by natural or mechanical means. Exhaust outlets should be located to limit the path of air travel to minimize temperature rise in the space.

Check Mild Weather Results Too

As a rough check on the adequacy of the design, the air change rate for the system may be compared with rule of thumb air change rates that have on the average provided acceptable results. These values, given in Table 6, do not take into account variations in heat gain and, thus, are only useful as a guide. One other check on the design might be made to determine the adequacy of evaporative cooling. This would be a determination of the results that will be obtained in moderate weather. If a large number of cool days have relatively high wet bulb temperatures, the evaporative cooler may provide less relief from this condition than it will at design conditions. This may suggest the use of higher air volumes, straight ventilation with the evaporative cooling system, or the use of mechanical refrigeration.

Where It's Used in Industry

In most localities, evaporative cooling can provide satisfactory relief in so-called hot industries. Its field of application is much broader in this use than for comfort cooling of office spaces or other spaces in which occupants are only moderately active. It may also serve as a process cooling device in which personnel comfort is of secondary importance. A list of potential applications[17] would include relief cooling of individuals in various metal working operations, the rubber industry around tire presses and mills, laundry and dry cleaning establishments, the textile industry, and other industrial operations in which the heat gain from the process is the primary heat source. It should be noted that where large radiant heat gains from high temperature surfaces occur, evaporative cooling may not in itself be sufficient. Radiation shielding may be needed for satisfactory results.

Process applications in which evaporative cooling would be expected to perform satisfactorily would include cooling of parts leaving paint and enamelling ovens, hot extruded products and similar processes. Generators, motors, and transformers may be cooled directly by blowing conditioned air through the windings. The air washer provides both dust free and cooled air for such applications. It is also suitable for cooling common storages for fruits and vegetables.

More recent applications in which evaporative cooling has been proven profitable are the cooling of greenhouses, and animal shelters where the increase in productivity and decrease in mortality quickly repay the installation costs.

In all of the applications mentioned, refrigerated air conditioning or process cooling can be used. In some cases, especially those in which high volumes of ventilation air are required, the cost of refrigeration would be prohibitive. Evaporative cooling provides a means of eliminating undesirable conditions in such circumstances at a reasonable cost.

Industrial Relief Cooling Design

The cooling of people in hot industries may take the form of general space cooling or it may be applied only to the individuals involved as spot cooling. The occupant density and the nature of the structure determine the approach to be taken. Where worker population is high and spaces have low ceiling heights, general space cooling would be suggested[18] with 100 percent of the air moved through the building being evaporatively cooled. Design procedure would be similar to that given earlier. Where worker population is low and building volume is large, spot cooling of the individuals would be most economical. The air volumes required to evaporatively cool the entire space would be difficult to justify.

Spot or Zone Relief Cooling

In an excellent general discussion of heat relief in industry, B. R. Small[19] recommended the following precautions to avoid improper practice when using evaporative spot cooling:

1) "Use all outside air and never recirculate in hot weather.

2) "Maintain adequate air motion around the men who are to be benefited. Though not scientifically developed, a minimum of 300 fpm, ranging to 1000 fpm under severe heat conditions, has been found successful." (These are in agreement with velocities that are obtained from the Belding and Hatch heat stress index.) "Adequately equipped air dampers that permit 80 percent velocity turndown are essential, thereby extending the system's usefulness to spring, fall and often winter, if room air is recirculated during these seasons.

3) "Provide a split system whereby evaporative cooling is used in combination with motorized exhaust ventilators and sufficient fresh air inlet openings sized to admit a two to five fold greater volume of raw outside air. This holds down the overall temperature level (and relative humidity) in all areas of an obviously hot operation and sweeps out the spent washed air.

"Exceptions to the split system are mill motor rooms, direct mill motor cooling, internal combustion engine rooms, and electrical control rooms because rapid air changes provide adequate air motion. In this field, there is an increasing use of air filter washers for the combined purpose of providing dustfree air and evaporative cooling."

In the successful installations described by Mr. Small in metal working operations such as casting, and remelting, target air velocities of 600 fpm are used when cooling a relatively large area. For spot cooling, each man received 2000 cfm or less as he desired with supply air velocities ranging from 400 to 1000 fpm based upon grille free area. The natural air path was directed at the waistline from a point near the shoulder. This supply outlet location was determined[20] by research to be most effective. Workers tend to object to an overhead blast which impinges on the head or face. By means of adjustable outlets, the worker can, if he so desires, direct any desired part of the air on his head or shoulders. Acceptance of the spot cooling system is directly related to provision for individual adjustment of the air stream pattern and volume.

Maximum saturation of the air is recommended[19] when the distribution system traverses hot areas. The increased dry bulb reduction will tend to offset temperature rise in the ducts at the expense of an increase in wet bulb tempera-

ture of the air delivered. Temperature rise in the ducts is also minimized by the use of high duct velocities. Velocities of 3000 fpm and higher have been used and average plant noise levels make this permissible. Careful design of the duct system is necessary. Duct insulation or the use of duct materials having low emissivities may also be required in extremely hot areas and where radiant heat gains are high.

Laundries and Dry Cleaning

Evaporative cooling of laundries and dry cleaning establishments requires the same precautions suggested above for relief cooling. In spaces with high ceilings, spot cooling is usually employed. Various air flow rates have been used with a minimum[21] of 500 cfm per worker, ranging up to 800 to 1000 cfm per worker in locations[22] such as Atlanta, Georgia. For adequate air motion around the workers, target velocities of 600 fpm are used with supply velocities of about 1000 to 1200 fpm. Adjustable supply outlets for control of air quantity and pattern are necessary.

In low ceiling spaces with relatively high worker population, general space cooling may be in order. Calculation of the internal sensible and latent heat gains — which are the principal gains to be considered — can be made with information provided in Reference 23 which gives sensible heat loads of various equipment used in this industry. Means for controlling latent heat gains by local exhaust ventilation at ironers and other equipment are also discussed. Local ventilation may in part meet the requirement of exhausting the spent washed air delivered to the space. For the rest, mechanical exhaust is preferred to natural exhaust to prevent possible build up of humidity.

Spot cooling of individuals in other hot industries would differ little from the systems used in the two preceding applications. If the same precautions are observed, satisfactory results will be achieved. However, evaporative cooling is not without limitations in industrial applications. High humidity may encourage rusting, which is particularly undesirable where precision instruments or machinery is present. Thus, evaporative cooling should be used with caution.

Greenhouse Cooling

An interesting application of evaporative cooling is control of temperature in greenhouses. Relative humidity is not a factor in plant growth[24] when the plants are watered regularly and have developed a large root system. Thus, evaporative cooling can be used successfully in any area to produce significant increases in plant production and quality which are attributable to the temperature reduction achieved. Heretofore, greenhouse summer temperatures have been controlled by natural ventilation and the application of shading compounds on the glass to reduce solar gains. Evaporative cooling can maintain[24] temperatures of 75 to 85 F so that full advantage can be taken of the sun for growth and at the same time eliminate the bacteria, insects, dust, etc. that are admitted when natural ventilation is used.

The solar heat gain is, of course, the most important load to be considered in the heat gain computation for a greenhouse. Of the total solar gain, however, only 50 percent must be removed[24] by cooling. The remainder is converted to latent heat (48 percent) or used in the photosynthesis process (2 percent).

Uniform air motion is important because all surfaces of the plant must be cooled. At the same time, velocities must be held to a minimum to prevent plant damage. Velocities[24] of 20 to 50 fpm are optimum and 400 fpm is too high.

A system designed for this application[25] uses aspen wood pads in one side of the house with exhaust fans in the other so that air is drawn across the planting beds. The pads are wetted by a perforated trough or pipe. Excess water drains to a gutter, is then collected in a sump and recirculated. Water is supplied to the pads at the rate of 1/3 gpm per linear foot of pad. The air velocity through the pads is about 123 fpm. The pads are installed so they can be covered in winter or replaced with glass. With this system, inside temperatures less than 90 F are maintained in a New England installation. Unit type coolers are also used[26] for greenhouse cooling.

Other applications in which evaporative cool-

ing can be effectively used that should be noted are the conditioning of common storages for fruits and vegetables, sweat rooms for degreening citrus fruits,[27] and animal shelters. Dairy barns, poultry houses, and swine farrowing houses, can be cooled with resultant gains in productivity and decreased mortality in the most humid areas. Many animals — chickens and swine for example — do not sweat. Their comfort depends primarily upon dry bulb temperature, so high local humidities do not limit the use of evaporative cooling in this application as they do in the case of comfort cooling of humans. A one minute air change[28] is usually used in these systems. This will provide shelter temperatures of 85 F or less.

How They Are Controlled

Control of the evaporative cooling system is important and should be given careful consideration. Numerous control systems can be devised to meet the requirements of a particular application. The direct cooler is often controlled by a dry bulb thermostat which operates the cooler — blower and water supply — on changes in room dry bulb temperature. Modulating dampers are preferred[29] by some designers of evaporative cooling systems. These should be particularly effective in areas with low dry bulb temperatures. This method provides constant air circulation — an important consideration in evaporative cooling. The fan is stopped at a predetermined minimum supply temperature. Where the modulating dampers appear costly, the water supply is controlled by the thermostat. This method gives much less critical control with overheating occurring during the off periods. However, constant air circulation is obtained in this way. Since the evaporative cooling system can be used for ventilation, automatic control can be used to shut down the water supply during mild weather and at nights when evaporative cooling is not needed to provide comfortable results. Two speed fans with automatic control of fan speed are also used to achieve better control. When several units are used in parallel, the control can be arranged to cut off one or more coolers to modulate air temperature.

Two stage evaporative cooling systems can also be controlled[30] in a number of ways. In one installation, a two-stage dry bulb thermostat first starts the direct evaporative cooling stage. At a preset higher temperature, the dry cooling stage is cut in to provide maximum cooling.

Another method[30] of controlling the two-stage system is to start the evaporative cooling stage at a predetermined outdoor temperature. As outdoor temperature rises and the load on the system increases, the dry cooling stage is set in operation at some predetermined outdoor temperature. An indoor thermostat then takes control of the entire system.

Maintaining the Evaporative Cooling System

Proper and preventive maintenance is important to satisfactory operation of the evaporative cooling system. The systems are relatively simple so that maintenance is not extensive but frequent inspections may be required.

Routine inspection and service common to blowers and motors should be carried out periodically. This will help prevent development of excessive noise in these components.

The most important aspect of maintenance is keeping the water distributing components in top working order. This includes pads, nozzles, etc. With recirculating water systems, the mineral concentration of the water builds up as a result of evaporation. Scale deposits form that plug or clog the wetted surfaces and reduce air flow. A method commonly used to control scaling is to bleed sufficient water to keep reconcentration of solids at a minimum. In some cases, water is bled continuously, in others the tank contents are dumped batchwise at predetermined time intervals. Continuous bleed is preferred[31]

though dumping is adequate if done before the mineral concentration is high enough to deposit scale.

Water treatment is sometimes used in conjunction with bleed to prevent hard scale formation. It is also used to control algae growth — a source of undesirable odor — and corrosion.

Pads exposed to outdoor air will gradually become dirty through collection of dust, leaves, etc. Frequent inspection of the pads should be made and they should be replaced when visual inspection indicates deterioration or plugging. Excelsior pads should be replaced annually.

When spray equipment is used, nozzles, baffles, and cells should be cleaned periodically. Frequent need for cleaning the water distributing parts would suggest that water treatment measures are not adequate.

Wisely Used — A Useful Tool

Evaporative cooling is obviously not a replacement for refrigerated air conditioning in many comfort applications. It is a "tool," however, that when properly applied can serve many needs well. Used wisely it may provide cooling where economics preclude refrigerated air conditioning. In some cases, it may provide the first step in a program of refrigerated air conditioning and some components of the evaporative cooling system may be used later when the conversion to refrigeration is made.

Many rules of thumb have been derived for application of evaporative cooling. These provide helpful check points but they are not a substitute for careful engineering design. Properly applied and designed systems will avoid the common failures of evaporative cooling systems. Evaporative cooling will then be found applicable in many localities in addition to the dry "southwest."

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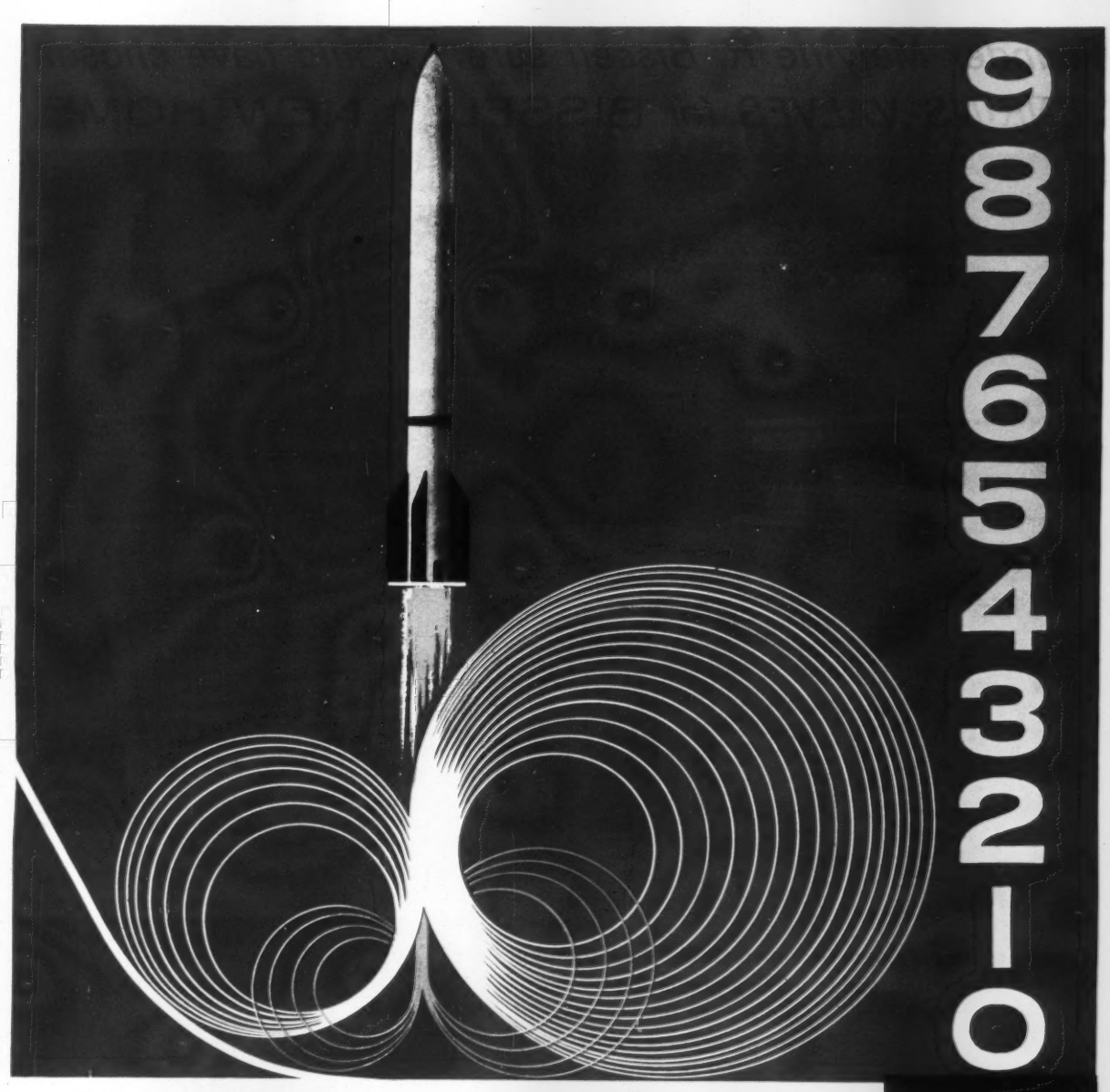

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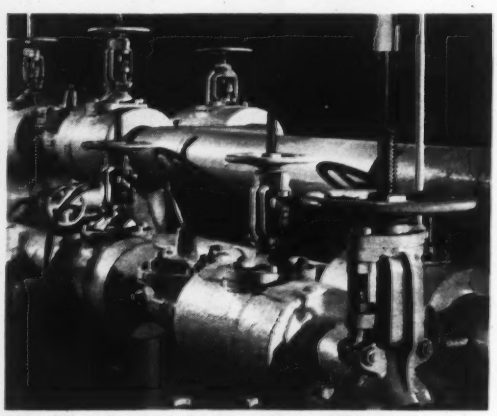

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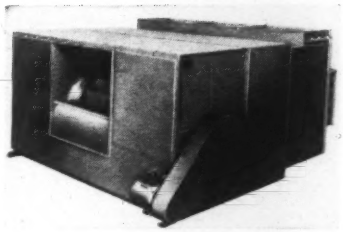

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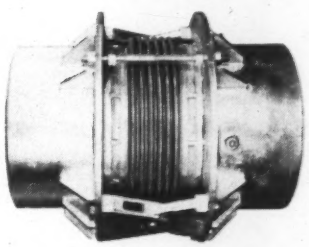

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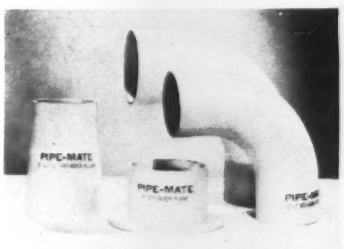

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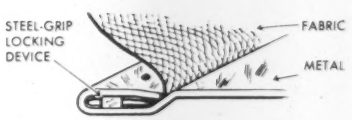

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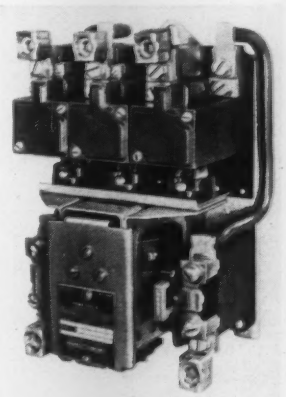

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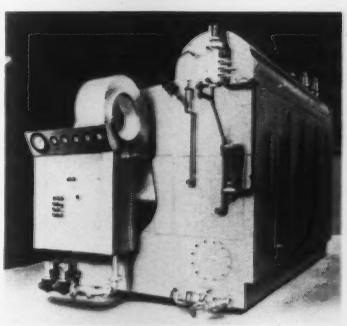

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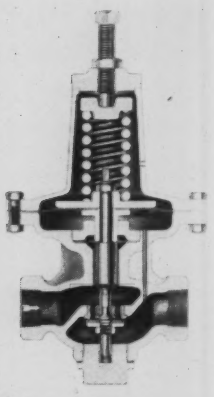

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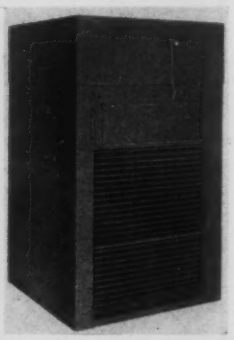

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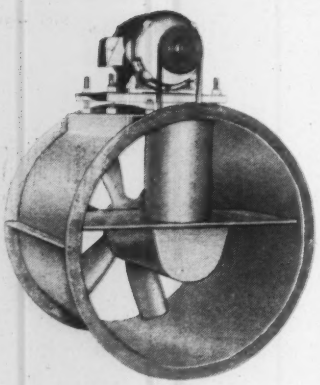

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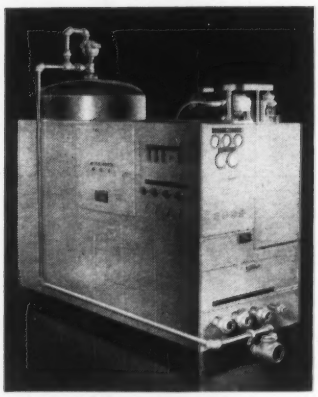

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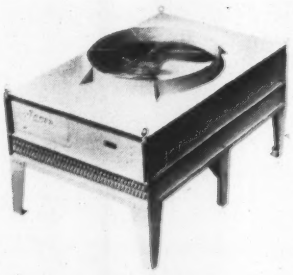
Pipe Alignment . . .

. . . guide for expansion, contraction of pipe lines and for tubing applications; of wrought steel construction, features split spider and casing for ease of installation; bulletin "1960" available on request—*The Align-O Pipe Guide Co., 55 Beaver Drive, Barrington, N. J.*



Air-Cooled Condenser . . .

. . . of 5 to 100 tons capacity, in 17 sizes; horizontally mounted, has four-blade fan, aluminum fins, 30 in. legs for proper air flow; features low silhouette, according to manufacturer —*Acme Industries Inc.*, 600 *N. Mechanic St., Jackson, Mich.*

U. S. ROYAL V-BELTS from the Power Unlimited complete belt line

Forget your experiences with V-Belts on air-conditioning units

The U. S. Steel Cable V-Belt has everything required in a belt for air-conditioning use. Here is a V-Belt that's in a class by itself. It is equipped with pulling members of steel. A new patented curing method and electronic tensioning of the steel cords free this belt from vibration. It transmits power smoothly, quietly and efficiently—and in present automotive air-conditioning service lasts 1½ to 2½ times longer than any other V-Belt. Here are the unequalled advantages the engineers point out:

- All-steel cable members lie in the same plane.
- Wire cable members are straight, never wavy.
- Absolute uniform top width and belt thickness for better seating in pulley.
- Perfect dynamic balance.
- Use of knurled mold insert provides maximum traction and alignment of outside idler.

Our transmission belt field engineers stand ready to consult with you on any or all V-Belt problems. Drop us a line at address below. . . .

When you think of rubber, think of your "U.S." Distributor. He is your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

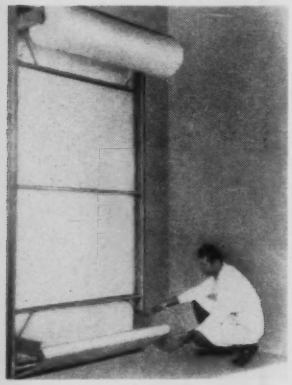
Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

EQUIPMENT DEVELOPMENTS
Continued



Disposable Filter . . .

. . . manual roller type designed for 0.3 to 0.6 in. water gage pressure differential at 350 to 500 fpm; carries 70 ft media rolls in 3, 4, or 5 ft widths; modular units range from 5 to 15 ft in height in 4 in. increments —*Farr Co., P. O. Box* 90187, *Airport Station, Los Angeles* 45, *Calif.*

Proportioning Pump . . .

. . . pneumatically operated for automatic control of industrial process water, feeds chemicals proportionate to pH concentration under control pressure of 3 to 15 psig or in proportion to varying flow rate, or both—*B-I-F Industries Inc.*, 345 *Harris Ave., Providence, R. I.*

Air Chisel . . .

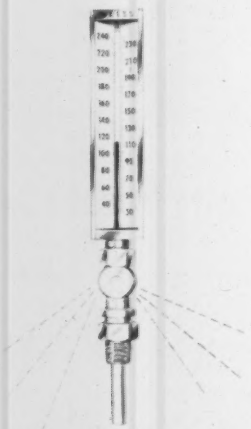
. . . for variety of operations on metals, rivets, welds, bolts, bearings; features one-piece barrel and cast iron handle; does not create fire or explosion hazard, according to manufacturer—*Albertson & Co. Inc.*, 3100 *Lowell St., Sioux City* 2, *Ia.*

Leak Dectector . . .

. . . for locating refrigerant leaks in halogen atmosphere; portable electronic detector mixes sample with filtered air through probe to reduce halogen content; sensitive to leaks of ½ oz per year and up, according to manufacturer—*General Electric Co.*, 1 *River Rd., Schenectady* 5, *N. Y.*

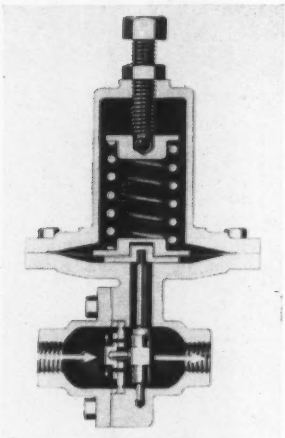
Radiation Partition . . .

. . . to permit installation of perimeter baseboard systems prior to partition erection; allows clearance for damper operation and butt for finish plaster; has glass fiber insert between pipe and enclosure—*Slant Fin Radiator Corp., Apartment House Div.*, 130-15 89*th Rd., Richmond Hill* 18, *N.Y.*



Industrial Thermometer . .

. . . adjustable to any angle before or after installation; locking device consists of single jam nut designed to be easily accessible; adjustable connection encloses lower portion of thermometer glass; temperature range from 30 to 240 F—*Albert A. Weiss & Son Inc.*, 261 *Vanderbilt Ave., Brooklyn* 5, *N. Y.*

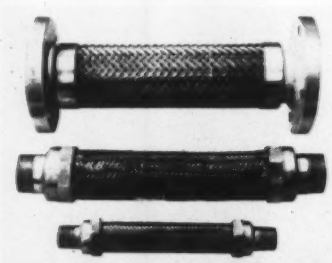


Gate Valve Seat . . .

. . . for regulators and control valves in ¼ to 3 in. sizes; of stainless steel, seats will reduce valve flow capacity in small increments to suit individual requirements; bulletin "SRBc 2-60" available upon request—*OPW-Jordan Corp.*, 6013 *Wiehe Rd., Cincinnati* 13, *O.*

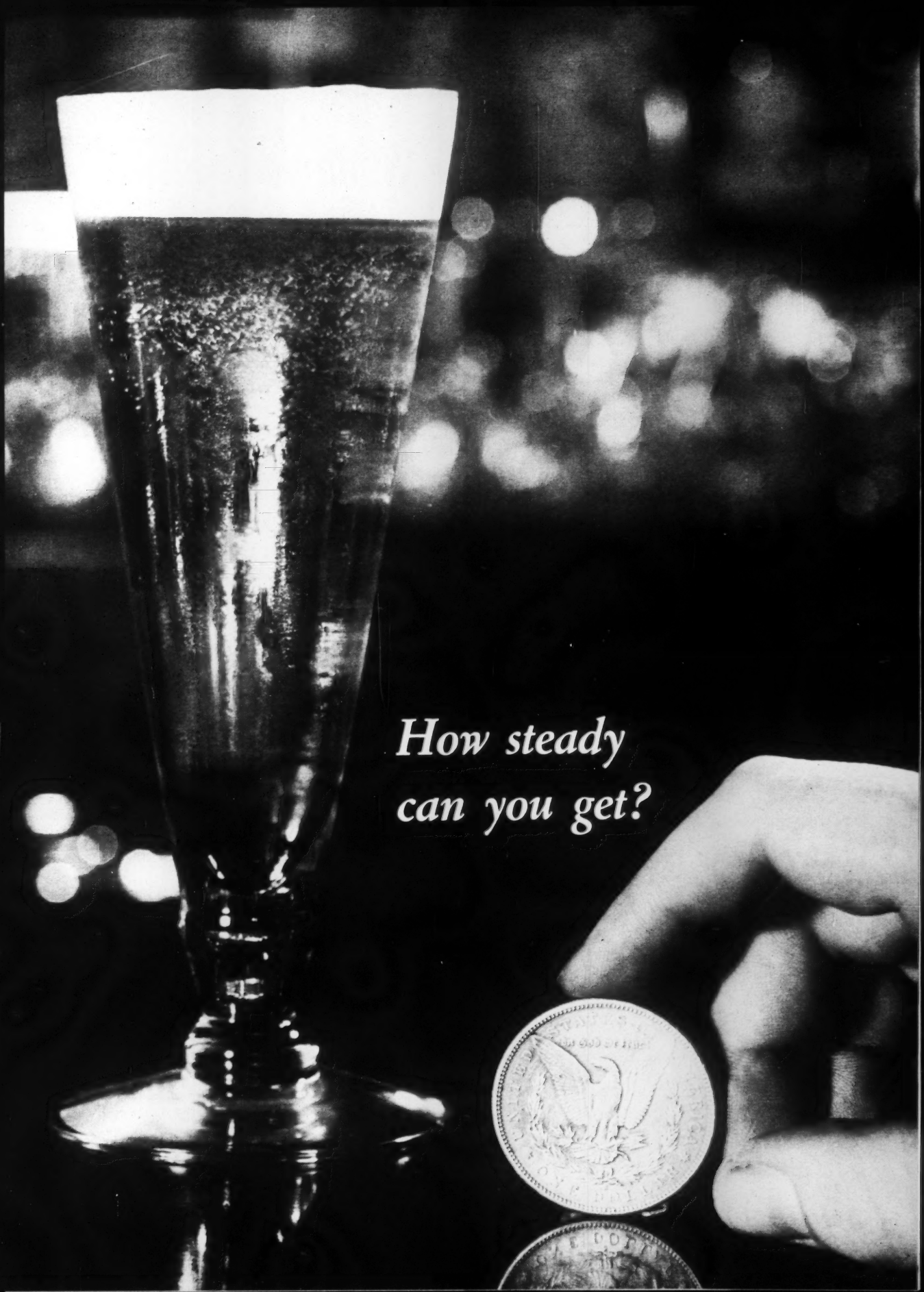
Pipe Insulation . . .

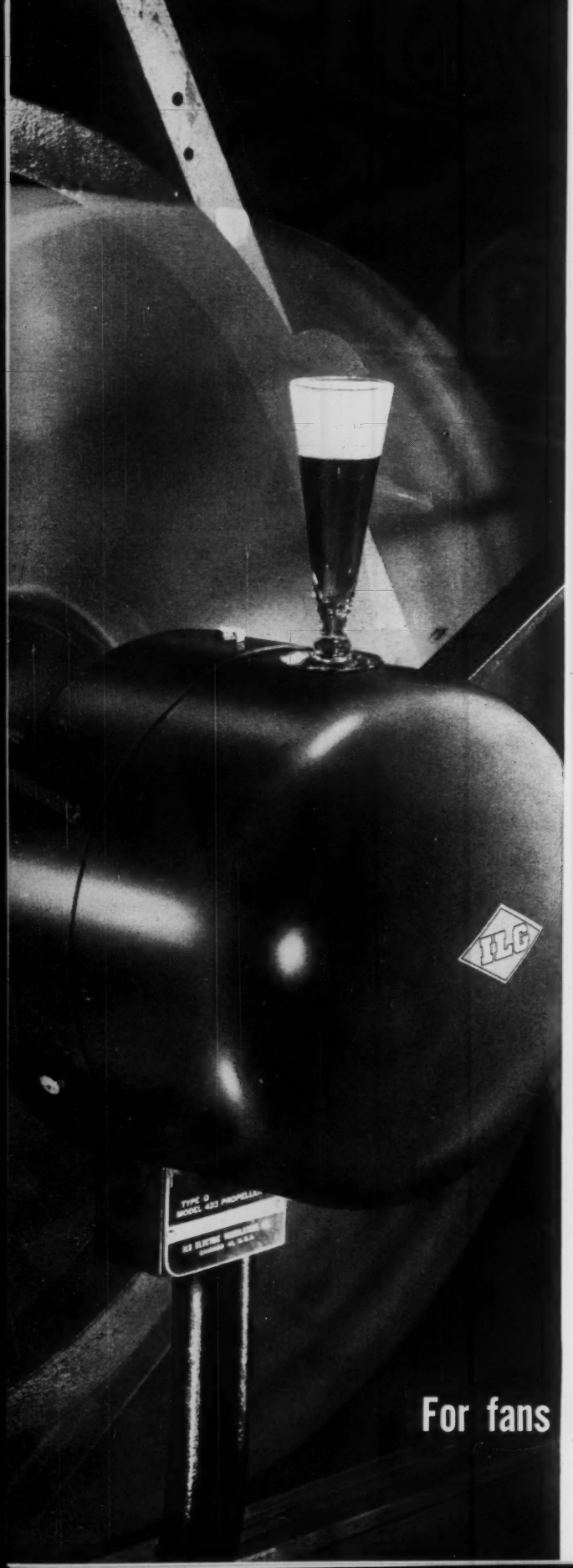
. . . composed of calcium silicate-asbestos felts for temperatures of 200 to 1200 F; available in sectional or tubular form, various thicknesses for pipe sizes of ½ to 24 in. diam and larger sizes on request—*Keasbey & Mattison Co., Butler Ave., Ambler, Pa.*



Flexible Connectors . . .

. . . to compensate for thermal expansion and vibration on pumps and pipe lines; available in bronze, ½ to 4 in. ID, and in stainless steel, 5 to 12 in. ID, for pressures up to 600 psi, according to tube ID and material—*Pennsylvania Flexible Metallic Tubing Co.*, 7200 *Powers Lane, Philadelphia, Pa.*


How steady
can you get?

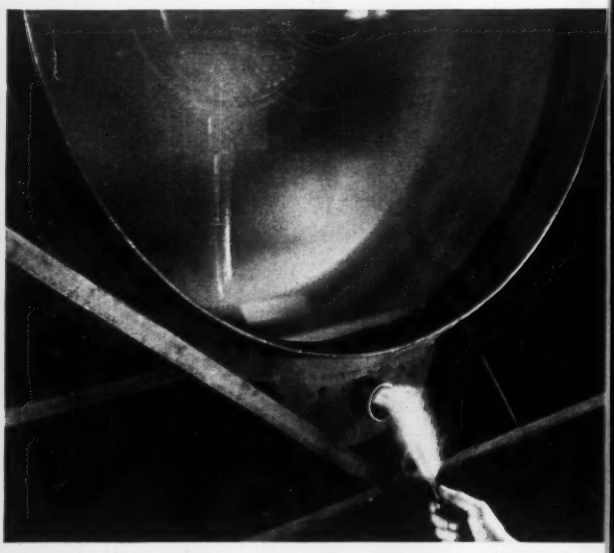


When you get ILG vibration is

Put a full Pilsner on any Ilg propeller fan. Flip the switch so the fan runs at full speed, just as you see it on this unretouched photo.

Now check the glass. Any bubbles? None.

Ilg fans and ventilators eliminate vibration . . . cut down noise, too. Reason? Careful dynamic balancing of all component parts. Electronic checks of motor and fan wheels—before and after final assembly—make certain that smooth, silent operation is as much a part of each



Follow the Flame and see why Ilg direct-connected propeller fans always run "cool." Vent pipe sucks in outside air that *pressure-cools* the permanently lubricated, Ilg-built motors, both the single-phase permanent-split capacitor and 3-phase types. To find out how Ilg offers operating cost advantages of *open-type* motors plus better protection than *totally enclosed* motors, send for Catalog 159.

For fans built to satisfy your "specs"...

fans and ventilators

never a problem

piece of Ilg equipment as the "One-Name-Plate" guarantee of performance.

For further information, write for catalogs covering the complete line of Ilg electric ventilating equipment.

Each Ilg product shown carries the rating seal of the Air Moving and Conditioning Association Inc.

Short in Height . . . Long on Performance. Ilg Type LSQ power roof ventilators have direct-connected, patented "Q" Type fan wheels that pass air over blade smoothly, eliminate noisy turbulence. Low starting torque lengthens life of 3-phase and permanent-split capacitor single-phase motors. Choice of 11 sizes. Write for Bulletin 2302. For facts on type L-CRF *airfoil* centrifugal power roof ventilators, send for Bulletin 2701.

Perfect Balance. Every Ilg-built centrifugal fan wheel—with backward curved (BC) blades and *airfoil* design that eliminates eddy currents and turbulence—passes dynamic balancing "check-out" tests before being direct-connected to 3-phase or permanent-split capacitor single-phase motors.

Smooth Air Intake. Ilg centrifugal fans feature large air-intake area with gently curved inlet contours that assure smooth entry of air. No bearings or bearing supports to hamper intake air flow. Direct connected and belted types. Standard construction is suitable for Class I, II, III operation to 9" static pressure. Write for Bulletin 257.

specify ILG®

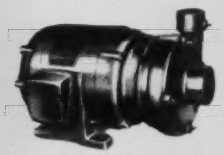
ILG ELECTRIC VENTILATING COMPANY

2826 N. Pulaski Road, Chicago 41, Illinois

Offices in More Than 57 Principal Cities

Member of Air Moving and Conditioning Association, Inc. (AMCA)

take little space, yet pump up to 260 G.P.M.



Weinman Type AC pumps can be mounted in any position, with shaft horizontal, vertical or at an angle.

WEINMAN
air conditioning pumps

There are over 60 Weinman Type AC pump models. Output ratings range up to 260 g.p.m., total dynamic heads to 150; horsepower ratings from ¼ to 7½. This breadth of choice assures you of the model pump exactly matched to any requirement. That's why compact, versatile Weinman Type AC pumps are favorites of air conditioning contractors and equipment manufacturers alike. These pumps take very little space. And, because they operate without trouble in any position, Weinman AC units are easy to mount in tight places.

Talk over your air conditioning pump needs with a Weinman Pump specialist. He's listed in the Yellow Pages. Or, write us for free Bulletin No. 100 — gives full details and performance curves.

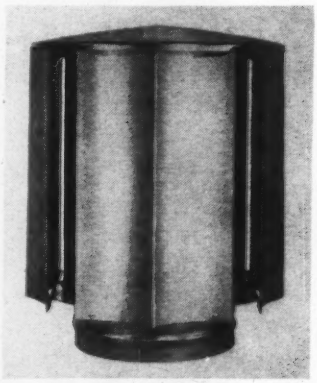
50th Anniversary 1909-1959

THE WEINMAN PUMP MFG. CO.
290 SPRUCE ST. COLUMBUS 8, OHIO

MEMBER

Centrifugal Specialists

EQUIPMENT DEVELOPMENTS
Continued



Gravity Ventilator . . .

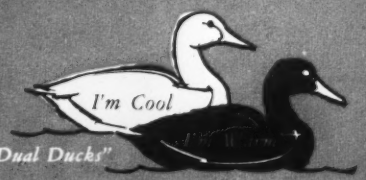
. . . incorporating airfoil principle; said to insure positive ventilation regardless of wind direction; in 4 to 24 in. sizes; bulletin "TE-112" available—*Triangle Engineering Corp., P. O. Box 7464, Houston 8, Tex.*

Induction Motors . . .

. . . high speed squirrel cage in 100 to 5000 hp, 514 to 3600 rpm; combine one-piece, wrap-around steel plate cover and double end ventilation openings, stainless steel rotor retaining rings, oil lubricated bearing —*Ideal Electric and Mfg. Co., E. First & Oak Sts., Mansfield, O.*

Motor Control Centers . . .

. . . with capacity from 200 to 2000 amps, 110 to 600 volts; comprised of two or more starters fed from common bus, available as fusible or circuit breaker units; offer installation and space-saving advantages of centralized control, according to manufacturer—*Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.*



Meet our "Dual Ducks"

dual-duct

by Buensod is an extremely efficient system of air conditioning the year 'round. In the Dual-Duct method, warm air flows through one duct, and cool air through the other. They are combined by the patented Buensod Air Mixing Unit in response to a thermostatic setting. And with self-contained Automatic Volume Control, pioneered and perfected by Buensod, it is impossible for zones to be thrown out of balance. Regardless of variance in static pressures, air volume is maintained ±5%. Ask your Buensod representative, or write us, for the complete story.

BUENSOD DUAL-DUCT

Buensod-Stacey, Inc., 45 West 18th St.
New York 11, N.Y.

BUENSOD-STACEY

"from Chicago"

—immersi-pump—

Trademark

SUBMERSIBLE NON-CLOG SEWAGE AND SUMP PUMP

- Pumps Sewage and other Liquids Containing Solids up to 2½"
- Operates with pump and motor completely submerged

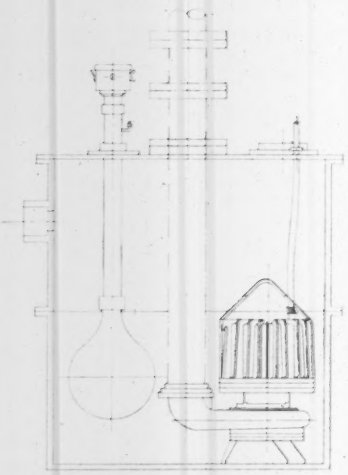
Check these SEVEN important features

1. Low original cost
2. Low maintenance cost
3. Easy to install
4. Easy to service
5. No superstructures required
6. Minimum headroom needed
7. Makes more floor space available

PLUS

Exclusive SEALTRODE Sealed Electrode Floatless Pump Controller . . . the only controller featuring completely sealed Electrodes . . . positively preventing insulation or coating by grease or other corrosive elements.

Ask for Bulletins Nos. 97 and 128-A.



Typical installation—single unit—duplex installation available

51 YEARS 1910 CHICAGO PUMP COMPANY 1960

"Chicago" Distributors are located in most principal cities. See the one nearest you today for full details.

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Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Chicago Pump Company

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EQUIPMENT DEVELOPMENTS

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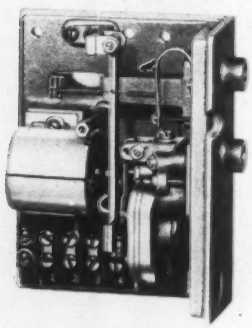
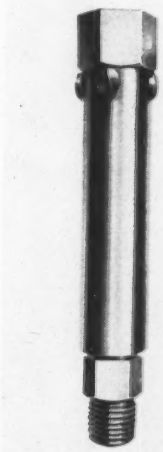


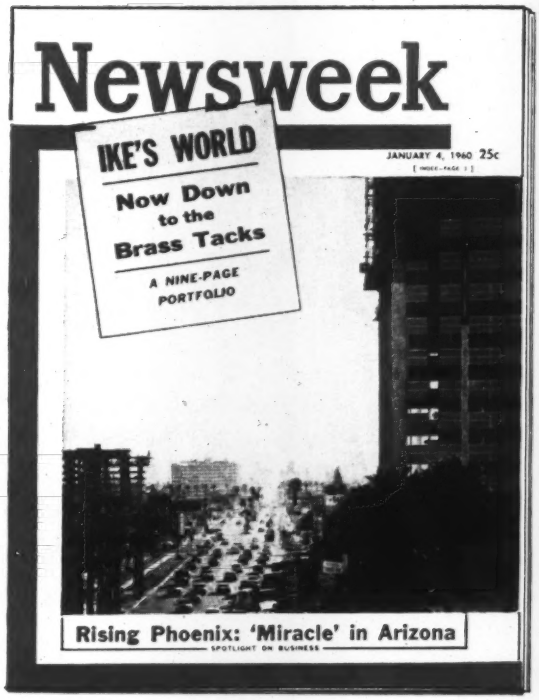
Load Limiter . . .

. . . for protection against motor overload, installs in pneumatic control system of centrifugal refrigeration compressors, operates on 3 to 7 amps, has remote manual adjuster for 40 to 100 percent maximum motor current; can be applied to motors of any size—*Johnson Service Co., Milwaukee 1, Wis.*



Check Valve . . .

. . . for protection against loss of manometer fluid when over-range pressures are encountered; features special O-ring diaphragm which seals against valve cone; of stainless steel with interchangeable heads for various liquids; operates up to 500 psi—*Petrometer Corp., 43-22 Tenth St., Long Island City, N. Y.*



For ECONOMY CONTINENTAL *clears the air* with CONOMANUALS for new GUARANTY BANK BUILDING

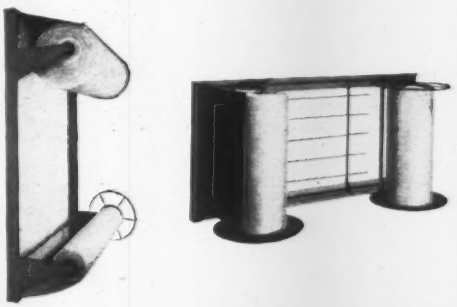
Newsweek's "Cover Girl" for January 4, 1960

Dominating the Phoenix, Arizona, skyline, the new Guaranty Bank Building will be air-conditioned by two large systems handling a total of 182,630 CFM.

Originally, it was planned to use cleanable filter cells, with enough spare cells to permit one-half of the filters to be cleaned at a time. The cost of Conomanual Filters was only slightly higher than original cost of filter cells with spares, and when cleaning every 6 weeks was considered the **savings with Conomanuals offset the original cost difference in 6 months and offered a substantial future savings . . . plus greater convenience.**

Whenever air filters are involved – in new installations or old – you'd do well to let Continental clear the air for you. Contact the Continental representative in your area – or write direct.

ARCHITECT	Charles G. Polacek, Phoenix, Arizona
CONSULTING ENGINEER	Biddle & Young, Phoenix, Arizona
GENERAL CONTRACTOR	Henry C. Beck Company Home Office – Dallas, Texas
AIR CONDITIONING CONTRACTOR	Farwell Company, Inc. Home Office – Dallas, Texas
OWNER	David H. Murdock Development Co. 3424 N. Central Avenue, Phoenix, Ariz.



Remington Stud Driver

Most versatile powder-actuated fastening tool made

The basic Power Unit...

Here's the single basic tool that gives you a new degree of on-the-job fastening versatility. Only *one* basic unit to buy — the Remington Model 455A — for all your fastening applications. Just choose the instantly interchangeable fastening attachment you need to do the job!

Plus choice of 4 fastening attachments...

K-1 1/4" & 3/8" Light Duty Captive Stud Attachment uses 22 cal. Power Loads. Use where extra safety is needed.

K-2 1/4" Light-Duty Attachment uses 22 cal. Power Loads. Handles 80% of your fastening jobs.

K-3 3/8" Medium-Duty Attachment drives heavy-duty studs with inexpensive 22 cal. Power Loads.

K-4 3/8" Medium and Heavy-Duty Attachment. Uses both 22 and 32 cal. Power Loads. For toughest jobs.

offers greatest single-tool fastening versatility!

The Remington Stud Driver offers these exclusive features:

- Four fastening attachments for light, medium, heavy-duty work, including the special Captive Stud Attachment for extra-safe fastening. No other single tool can cover such a variety of applications.
- Medium-duty fastening—requiring ⅜" studs—can be done with low-cost 22 caliber Power Loads.
- Positive one or two-hand operation at operator's option . . . no buttons or release to hold while fastening.
- Greater variety of applications made possible with instantly interchangeable guards. These 4" square, hollow "safety guards" fit snugly over work, trap spall and dust. More than 40 types are available.

Send coupon for free booklet about the Remington Stud Driver—your best buy in powder-actuated fastening tools!

Remington

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Please send—without obligation—information on Remington Contractor & Industrial Equipment checked below:

☐ Stud Drivers ☐ Air Tools ☐ Chain Saws
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*Name*_____ *Position*_____
*Company*_____
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EQUIPMENT DEVELOPMENTS

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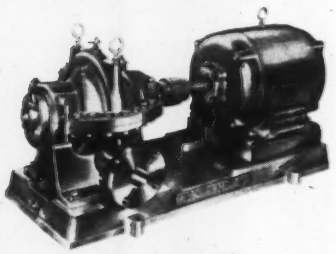
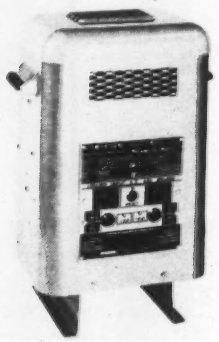


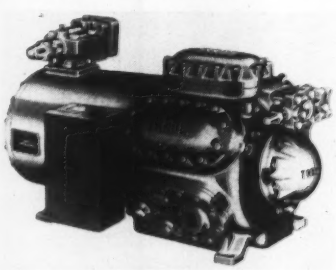
Centrifugal Pump . . .

. . . with mechanical seal designed for leak-proof operation; available in discharge sizes to 6 in., capacities to 2000 gpm and heads to 400 ft; bulletin "AY 1850" on request—*Weil Pump Co., 1530 N. Fremont Ave., Chicago 22, Ill.*



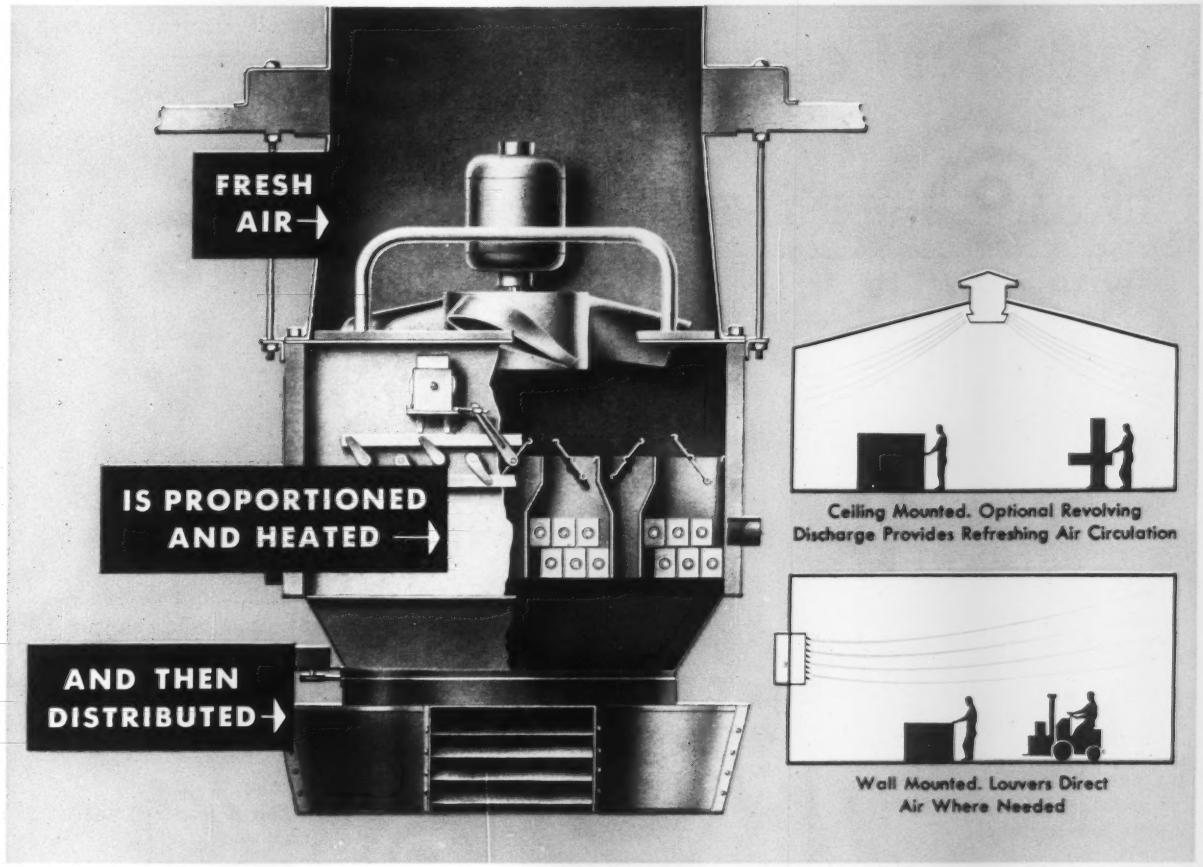
Portable Welder . . .

. . . 180 amp, total weight 68 lb, has 78 open circuit voltages with 75 percent power factor, six heat taps—*Emerson Electric Mfg. Co., 8100 Florissant Ave., St. Louis 36, Mo.*



Reciprocating Compressor

. . . hermetic, in 9 models, 10 to 100 tons; features one piece motor-compressor housing, numerous motor and compressor safety devices for protection of unit, reduced power requirements, according to manufacturer—*The Trane Co., La Crosse, Wis.*


FRESH AIR
IS PROPORTIONED AND HEATED
AND THEN DISTRIBUTED
Ceiling Mounted. Optional Revolving Discharge Provides Refreshing Air Circulation
Wall Mounted. Louvers Direct Air Where Needed

• Exhaust systems function better
• Workers are more efficient
with Wing Fresh Air Supply Heaters

Wing FAS Heaters offer three big advantages to plant operators:

1. They supply make-up air to compensate for air expelled through exhaust systems, and thereby improve the operation of the exhaust systems.
2. By providing slightly positive air pressures in the building, drafts and cold air leaks are eliminated — workers are comfortable.
3. When used to provide comfort ventilation, they help improve workers' efficiency and health.

Wing Fresh Air Supply Heaters provide constant air intake while automatically maintaining desired discharge temperatures. Usually, air is discharged at room temperatures and is directed above the workers' heads so that comfort is undisturbed.

The FAS Heater shown above operates with steam or hot water. Coils cannot freeze. Direct-fired gas units are also available. All can be provided for wall or ceiling mounting in a full range of capacities. A variety of revolving or fixed discharges meet any mounting height requirement. Also suited for use in fog elimination installations.

Send for literature describing construction and giving application information.

WC131

L. J. WING MFG. CO.
DIVISION OF AERO SUPPLY MFG. CO. INC.
140 VREELAND MILLS ROAD, LINDEN, NEW JERSEY
FACTORIES: LINDEN, N. J. AND MONTREAL, CANADA

WING

Cut Steel or Cast Iron Pipe up to 12" EASIER and FASTER

WITH THE *NEW*

REED

HINGED 4-WHEEL PIPE CUTTER

- Closed Frame Construction assures complete rigidity with less weight.
- 4-Wheel design needs minimum swing of handle.
- 4-Point pipe guide aligns cutter for perfect tracking of wheels and a right angle cut.
- Quickly interchangeable wheels for steel or cast iron.
- Needs only 3" space to pass under 12" pipe.

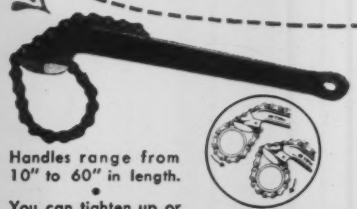
For ditch work or similar close-quarter operations these new Reed Cutters are practically indispensable and fully justify replacing whatever cutting equipment you are now using.

You can, for example, cut 8" steel pipe in less than five minutes, and cast iron pipe even faster.

Available in five sizes for steel or cast iron pipe from 1" to 12".

FOR FAST TURNING IN TIGHT SPOTS—

USE THE IMPROVED REED CHAIN WRENCH



Handles range from 10" to 60" in length.

•

You can tighten up or "back off" without taking wrench from pipe.

These improved chain wrenches will do anything an ordinary pipe wrench will do . . . and do it easier, better and faster. Ideal for ditches or tight corners.

Grip securely with no play, yet they have a ratchet-like action.

REED MANUFACTURING COMPANY

ERIE • PENNSYLVANIA

EQUIPMENT DEVELOPMENTS

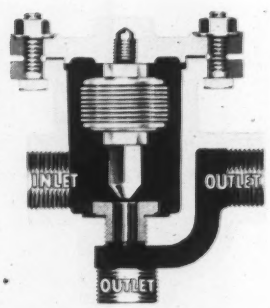
Continued

Compensator . . .

. . . for use in both heating and cooling systems on suction side of pump; operates on water or any other liquid, available in two sizes, installed in return line at pump inlet—*Cobra Pipe Supply & Coil Co., Inc., Elmwood, Conn.*

Combustion Indicators . . .

. . . employing lighted control panel to indicate fuel and air adjustment or malfunction of furnace; serves as smoke indicator, obviates need for CO_2 sampling, according to manufacturer—*Photomation Inc., 96 S. Washington Ave., Bergenfield, N. J.*

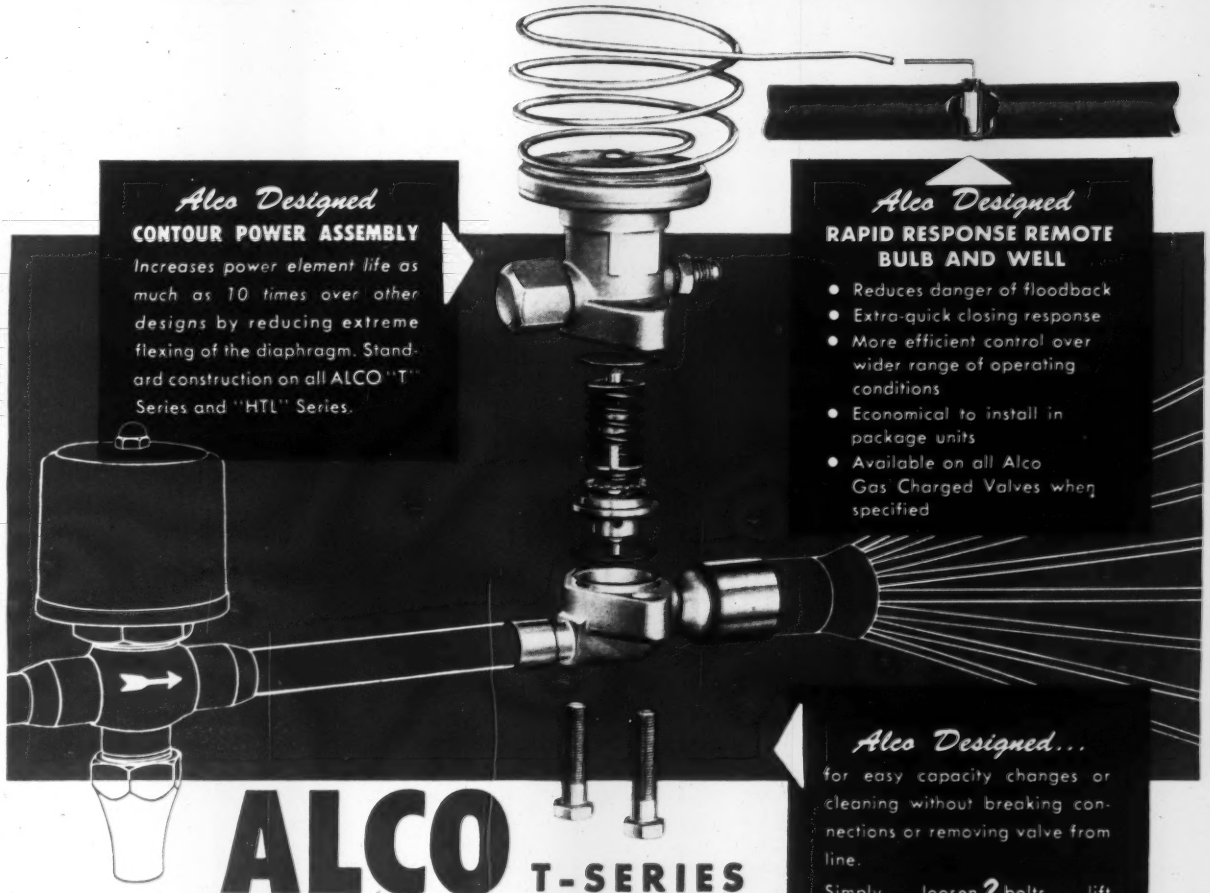


Steam Traps . . .

. . . for pressures from 0 to 300 psi and temperature to 500 F; available in cast iron, cast steel and brass in ½ to 2 in. sizes; traps are self-draining when piped with unobstructed bottom outlet—*The Clark Mfg. Co., 1830 E. 38 St., Cleveland 14, O.*

Engineered to

RETAIN YOUR PRODUCT LEADERSHIP



Alco Designed
CONTOUR POWER ASSEMBLY
Increases power element life as much as 10 times over other designs by reducing extreme flexing of the diaphragm. Standard construction on all ALCO "T" Series and "HTL" Series.

Alco Designed
RAPID RESPONSE REMOTE BULB AND WELL
- Reduces danger of floodback
- Extra-quick closing response
- More efficient control over wider range of operating conditions
- Economical to install in package units
- Available on all Alco Gas Charged Valves when specified

Alco Designed...
for easy capacity changes or cleaning without breaking connections or removing valve from line.
Simply . . . loosen **2** bolts . . . lift out cage . . . clean and replace.

ALCO T-SERIES
*THERMO EXPANSION VALVES

• Refrigerants: FREON-12 from ½ ton to 50 tons, FREON-22 from 1 ton to 80 tons, CARRENE-7 from ¾ ton to 60 tons, PROPANE from 1 ton to 88 tons • 2 BODY DESIGNS meet every requirement—STRAIGHT THRU CONNECTIONS or RIGHT ANGLE CONNECTIONS • WIDE VARIETY OF CONNECTIONS (Outlets to match distributor requirements • EXTERNAL or INTERNAL EQUALIZER • EXTERNAL or INTERNAL SUPERHEAT ADJUSTMENT • TIGHT SEATING . . . STAINLESS STEEL STEM AND SEAT • CORROSION-RESISTANT MATERIALS • MOUNT IN ANY POSITION • NO SPECIAL WRENCHES or GUIDES REQUIRED FOR CLEANING AND SERVICING

Call your ALCO WHOLESALER—Write for Bulletin 171-56

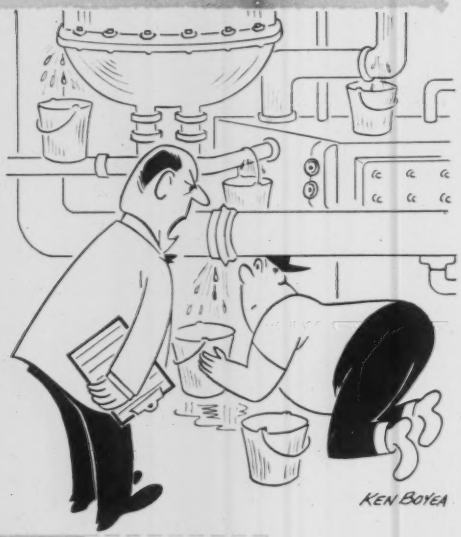
• *BUY SECURITY*
• *BUY QUALITY*
• *BUY ALCO*

ALCO VALVE CO.
861 KINGSLAND AVE. • ST. LOUIS 5, MO.

8218

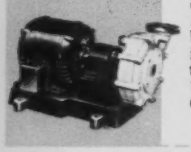
The one complete line of refrigerant controls: Thermostatic Expansion Valves • Refrigerant Distributors Solenoid Valves • Suction Line Regulators • Flooded Evaporator Controls and Reversing Valves

Life in these excited states...



"I don't care if it does do the trick in your attic!"

"WAM" PUMP
finest you can buy



Highest pumping efficiency, with faultless corrosion resistance. Hard rubber casing and impeller; Hastelloy *C* shaft. 80 gpm. *Bul. CE-55.*

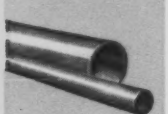
Fire the bucket brigade!

No time for passing the bucket when corrosion threatens. With one quick decision you put an end to 85 to 100% of these problems. Just specify *Ace* chemical-resistant plastic piping and rubber-protected equipment. The long-term cost is a drop in the bucket. American Hard Rubber Company's 108 years of experience is at your service.

THRIFTY-THROATED VALVES

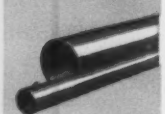
Liquids never touch metal in Ace diaphragm valves! Rubber or plastic-lined cast iron, or solid plastic bodies. Sizes ½ to 6". Ask for facts.

ACE-ITE
all-purpose toughie



High-impact, rubber-plastic, most economical for average chemicals. ½ to 6". Screw or solvent welded fittings. Valves ½ to 2". NSF-approved. *Bul. 80A.*

RIVICLOR
ageless strength



All-purpose rigid PVC. Sched. 40, 80 & 120, ½ to 4". Threaded or socket-weld fittings. Valves ½ to 2". NSF-approved. *Free Bul. CE-56.*

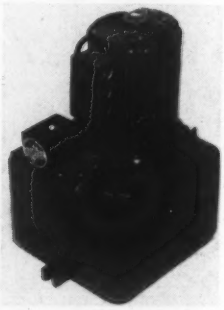
See our pages in cec Catalog!

ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
DIVISION OF AMERACE CORPORATION
Ace Road • Butler, New Jersey

EQUIPMENT DEVELOPMENTS

Continued

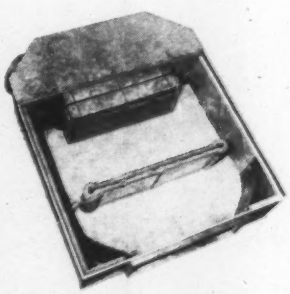


Condensate Pump . . .

. . . for small steam installations, has maximum capacity of 1200 sq ft E.D.R. at 20 psi; of non-corrosive material, has 1/3 hp 60 cycle 115 v or 230 v motor; features automatic liquid level control system—*Hartell, Inc., 60 York Rd., Warminster, Pa.*

Insulating Board . . .

. . . can be worked as wood, with white face finish; of inorganic composition, board is incombustible and resistant to rot and acid damage, according to manufacturer; available in 4 by 8 ft sheets, 1 to 3 in. thicknesses in half-inch increments—*Fibrous Products Div., Union Asbestos & Rubber Co., Bloomington, Ill.*

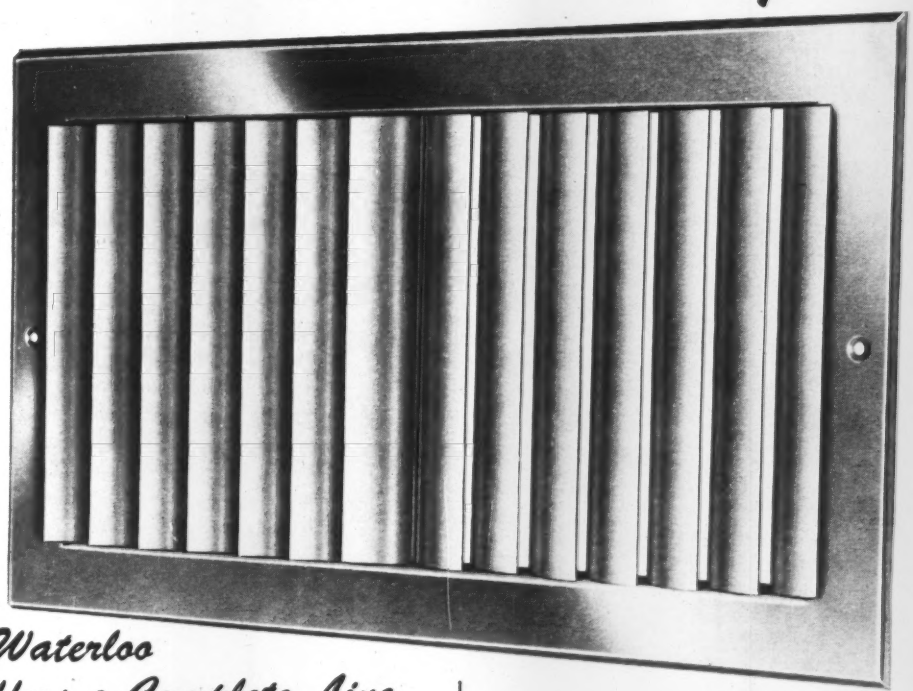


Air Valve Attenuator . . .

. . . for use in dual duct, high velocity air distribution systems; features direct pneumatic activation of valves and controls, calibrated for capacity determination; bulletin "K-45" available from manufacturer—*Connor Engineering Corp., Danbury, Conn.*

WATERLOO

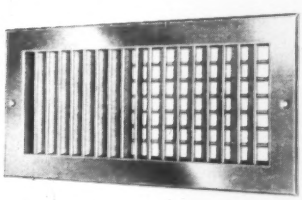
Curved Louver Grilles



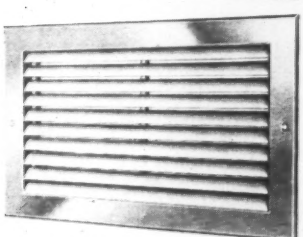
MODEL
1 CV2

Waterloo Offers a Complete Line

TYPICAL WATERLOO UNITS:

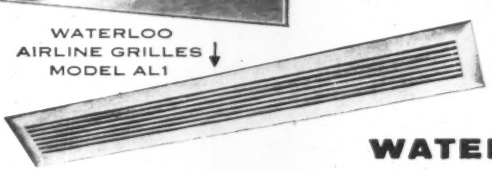


WATERLOO
SUPPLY
GRILLES
★
MODEL
2V



WATERLOO
RETURN AIR
GRILLES
AND
REGISTERS
★
MODEL
3HD

WATERLOO
AIRLINE GRILLES
MODEL AL1



WR117

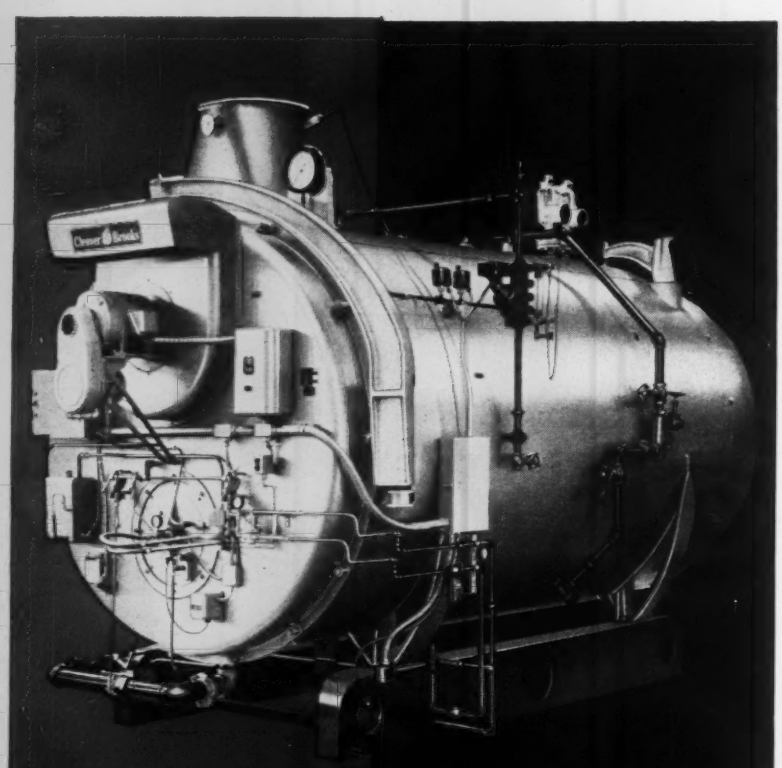
For Side Wall and Ceiling Applications

Waterloo Model 1C2 *curved louver supply grilles* offer two-way flow. They are designed for either side wall or ceiling applications where two-way air distribution is required. Waterloo also makes *curved louver grilles* in one-way, three-way and four-way flow designs. These units are available with either opposed blade or multi-shutter dampers, if desired. • **Waterloo's comprehensive catalog contains interesting application sketches of these curved louver grilles. Write for your copy.**

WATERLOO
Air Diffusion
EQUIPMENT

WATERLOO REGISTER COMPANY, INC.

P.O. BOX 72, WATERLOO, IOWA



It's what's up front that counts!

Engineering advances in Cleaver-Brooks CB packaged boilers (15-600 hp) offer every plant engineer and boiler owner greater efficiency, simpler maintenance

1. **Controls** and control panel all mounted on front head for operator convenience.

2. **Front head hinged** (or davited) to provide quick access to flues for cleaning and inspection without disconnecting fuel or electrical lines.

3. **Quiet operation** is result of radial blade, cast aluminum blower deep in front head with acoustically treated air inlet.

4. **Rotary air damper** modulates air for high combustion efficiency. Offers vibration-free control of air for positive draft.

5. **Cam operated fuel valves** driven by rugged linkage insure accurate, easy to adjust air-fuel ratios for highest combustion efficiency.

6. **Single tip retractable nozzle** simplifies cleaning since nozzle can be completely removed from firing position without opening front head or disconnecting oil or electrical lines. Single tip burner nozzle offers close-to-ideal mixing of air and fuel.

7. **Inspirating pilot** produces and maintains a pilot at zero gas pressure.

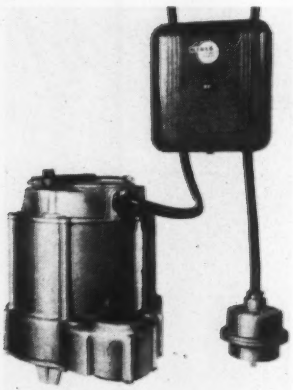
The new CB boilers up through 600 hp with an integrally-built air atomizing burner, atomize both light and heavy oils (including No. 6 oil). Oil is burned like gas — cleanly and completely. Every CB boiler meets four design standards—*four pass—forced draft* construction — *five square feet of heating surface* per boiler horsepower — *low furnace* location. For the complete design story, write Cleaver-Brooks Company, Dept. C 313 E. Keefe Ave., Milwaukee 12, Wis

Cleaver Brooks®

ORIGINATOR AND LARGEST PRODUCER OF PACKAGED BOILERS

EQUIPMENT DEVELOPMENTS

Continued



Sump Pump . . .

. . . for industrial use with 3-phase equipment; has 5000 gph capacity at 10 ft discharge head for ½ hp 230 v 3 amp operation; bronze impeller and sealed self-lubricating motor chamber for submersion; automatic self-starter or non-automatic models available—*Kenco Pump Div., The American Crucible Products Co., 1305 Oberlin Ave., Lorain, O.*

In-Line Valve . . .

. . . for ½ in. lines, rated for 300 psi at 180 F; ported both sides of operating piston, assembled for spring-to-open or spring-to-close operation or without springs for double acting piston hydraulic actuation; bronze sleeve, stainless steel plug—*George W. Dahl Co. Inc., 86 Tupelo St., Bristol, R. I.*

NEW DATA-

on operating and safety controls for jobs involving liquid level or liquid flow

This new book shows how McDonnell float-operated switches and valves, and flow switches, can be used to provide dependable, economical control for a wide variety of applications.

On hydro-pneumatic tanks, for example, or water chillers; with stand-by pumps and surge tanks; in water supply and proportioning systems. All in all there are 21 case studies in this book . . . and each one can suggest dozens of other specific applications.

These are the standard time-tested McDonnell products that heating men know so well, starring here in roles that may not be so familiar to you. To bring yourself up-to-date — to learn a lot of answers to a lot of frequently-encountered liquid level and flow control problems — get your free copy of this new Bulletin ERS-A.

McDONNELL & MILLER, *Inc.*
3500 N. Spaulding Ave., Chicago 18, Ill.

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New pressure controls . . . 0.5 to 150 psig.

Diaphragm Pressure Regulators

. . . with PLUS-PERFORMANCE FEATURES

Now . . . Robertshaw engineers answer still more of your pressure control problems with these highly efficient diaphragm-actuated companions to our famous *bellows* self-ops!

Ruggedly built and modestly priced, this new 1065 Series is offered in four diaphragm sizes, with nine different ranges from 0.5 to 150 psig. Single-seated ½″ to 2″ valves for positive shut-off . . . piston-balanced in the larger sizes; double-seated, 2½″ to 4″ sizes.

- **Nylon-reinforced, moulded Buna-N diaphragm**
- **Spring-loaded Teflon chevron lifetime packing**
- **Ball-bearing wheel adjustment**
- **Quick-disconnect, polished monel valve stem**
- **Stainless steel trim standard**
- **Highest quality chrome steel adjusting spring**
- **Valve designs backed by years of field service**

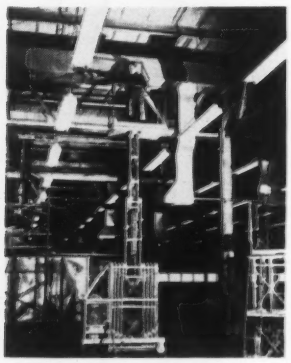
For complete specifications, ask for Bulletin EH-125. **Fulton Sylphon Division, Robertshaw-Fulton Controls Company, Knoxville 1, Tennessee.**

Robertshaw

MR CONTROLS

EQUIPMENT DEVELOPMENTS

Continued

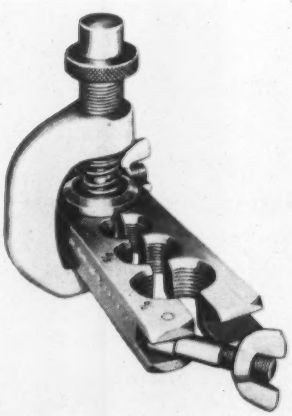


Telescoping Lift . . .

. . . for installation and service of overhead equipment, extends to 40 ft, available in manual or automatic electric models, may be trailer mounted for transport—*Economy Engineering Co., 4511 W. Lake St., Chicago 24, Ill.*

Recorder-Receivers . . .

. . . for remote or in-plant telemetering; feature 2, 4, 8, 15, and 60 second time-cycles; up to 16 control switches, multiple pen arrangements and modular construction; bulletin "TH-C" available on request—*Builders-Providence Div., B-I-F Industries Inc., 345 Harris Ave., Providence, R. I.*

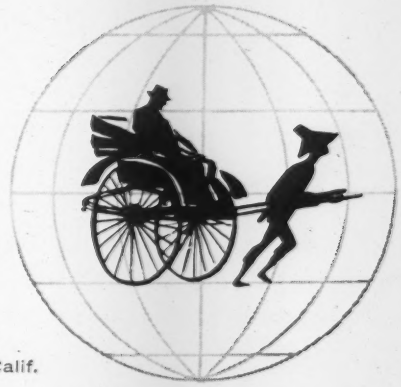


Flaring Tool . . .

. . . for ½ to 1⅛ in OD tubing; flares by striking tool's piston with hammer; literature available from manufacturer—*The Schaul Mfg. Co., 6300 Roland Ave., Cleveland 27, O.*

Engineering the temperature...
IN SINGAPORE

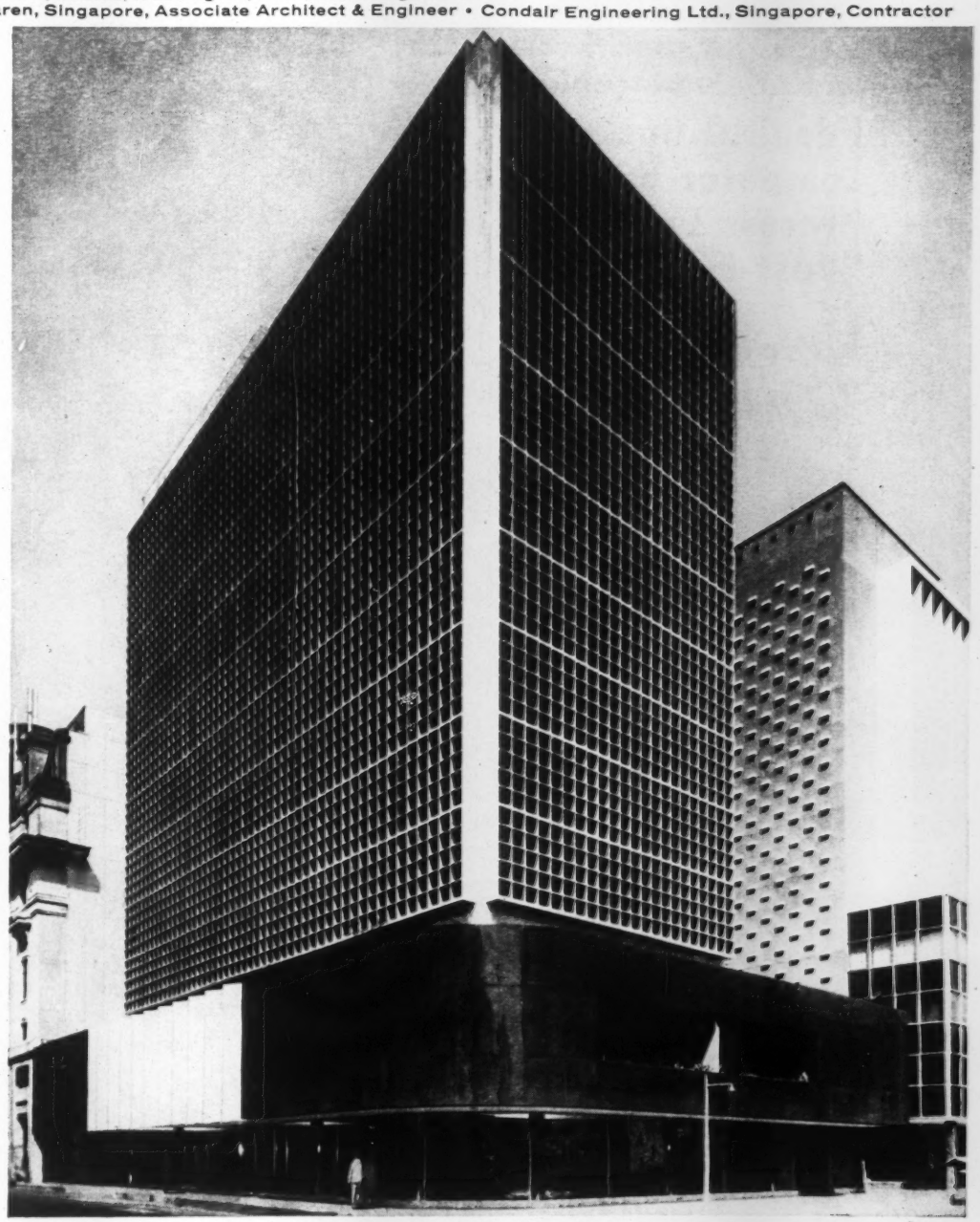
Twelve Recold Multizone units air condition the American International Assurance Building. These Recold Multizone units, one on each floor, supply 108,000 CFM of conditioned air for this modern, 34 zone, office building. One standard Recold air conditioning unit cools the executive penthouse.



RECOLD **CORPORATION**
7250 East Slauson Avenue, Los Angeles 22, Calif.

John Graham & Co., Seattle, Washington, Architect & Engineers
Swan & McClaren, Singapore, Associate Architect & Engineer • Condair Engineering Ltd., Singapore, Contractor

RECOLD



Just How Clean is clean Air

How clean must the air be in Commercial and Industrial Air Conditioning Systems

How can the specific clean air requirements be achieved in–

Hospital Operating Rooms
Computer Ventilating Systems
Process Exhaust Systems
"Dust-Free" Rooms

. . . and what is the POSITIVE, low-maintenance way to get it

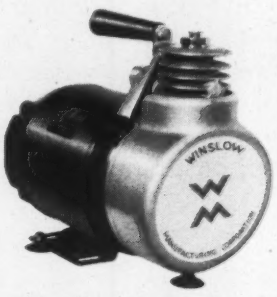
YOU'LL FIND MANY HELPFUL SUGGESTIONS IN BULLETIN 121

Write Today for Your FREE Copy . . .

Cambridge Filter Corporation
732 E. Erie Blvd., Syracuse 1, N. Y.

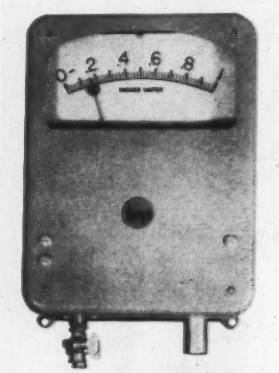
REPRESENTATIVES IN PRINCIPAL CITIES

EQUIPMENT DEVELOPMENTS
Continued



Air Compressor . . .
. . . portable, reciprocating with stainless steel cylinder liner; features non-lubricated piston, motor is ⅛ hp 115 v a-c; entire unit weighs 18 lb, capacity up to 100 psig—*Winslow Mfg. Corp., 3695 E. 10th Court, Hialeah, Fla.*

Activated Charcoal Paint . .
. . . said to give odor adsorptive properties to filter materials; can be used on filters, other materials such as plastic, metal, wood, paper; water soluble—*Barnebey-Cheney Co., Cassady at Eighth, Columbus 19, O.*



Indicating Transmitter . . .
. . . for low-to-medium pressures for use at point of measurement or distance up to 300 ft; for measurement of draft, flow of non-corrosive gases, ranges 0 to 0.2 in. up to 0 to 120 in. water gage at static pressures to 65 psig—*The Hays Corp., 800 E. 8th St., Michigan City, Ind.*

"Best valve made for air conditioning!"

Dial Indicator for Balancing Rectangular, Diamond or V Ports

All ACF Plug Valves may be equipped with dial indicators, which save time and inconvenience in recovering proper balance in air conditioning systems.

In addition to the popular rectangular port, ACF Plug Valves are also available in diamond and V port models for even more accurate flow control.

Product of W-K-M's *Creative Engineering*

ACF® Plug Valves

ACF lubricated plug valves give positive control at minimum expense for air handlers, compressing units, natural gas or fuel oil lines, and water towers.

No matter how long between operations, ACF plug valves open and close with an easy quarter-turn. Friction surfaces are constantly lubricated for smooth turning and protection against corrosion. A teflon gasket backed-up by a lubricant reservoir seals the head seat. The cylindrical plug — with a well-proportioned full pipe area port — provide an effective seal in the line.

Next time — and every time — specify ACF! *Available from leading suppliers everywhere.*

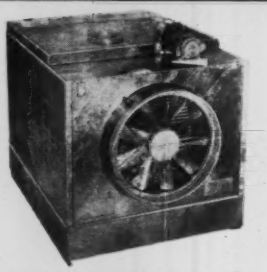
WRITE FOR BULLETIN AP-1059

W-K-M

DIVISION OF ACF INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

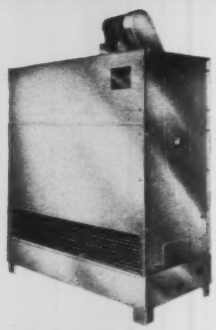
5924

it's MARLEY for



AQUATOWERS®

World's best-known steel mechanical draft cooling towers. Heavy-duty mechanical equipment, close-packed filling cube, exclusive diffusion deck and hot dip galvanized finish result in unequalled performance, economy and durability. 14 models from 3 tons up; dual units extend capacities to 120 tons nominal.



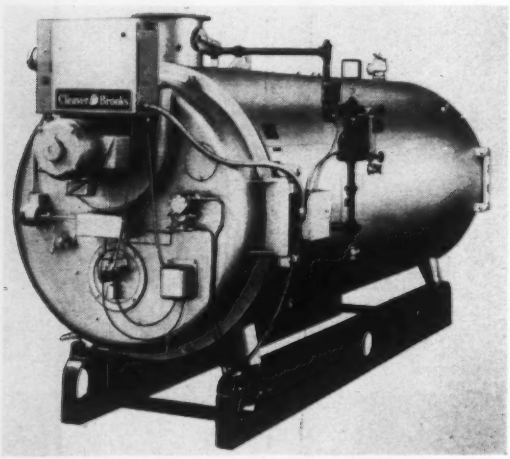
AQUACOOLERS®

Indoors or out, in minimum plan area, AquaCoolers can be easily and economically installed. Performance is full-capacity; operation is whisper-quiet and leakproof. Heavy gauge steel casings and basins, as well as centrifugal blowers and scrolls, are hot dip galvanized for extra service life. 10 models available, 5 to 90 tons, nominal.

OTHER MARLEY PRODUCTS:
SPRATOWERS® . . . for natural draft cooling
WOOD AQUATOWERS® and PERMATOWERS® . . . for longest life in corrosive atmospheres
DRICOOLERS® . . . air cooled refrigerant condensers

EQUIPMENT DEVELOPMENTS

Continued

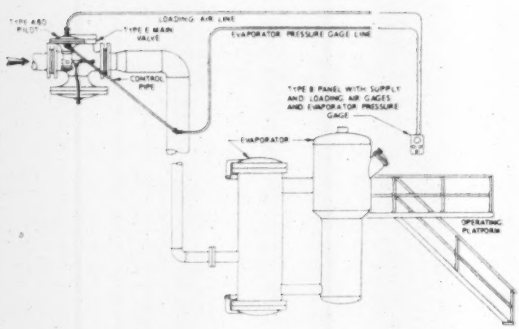


Package Boiler . . .

. . . for use with hot water or steam, in 25 to 100 hp range, high or low pressure; four-pass fire tube unit features numerous safety devices, front-mounted controls and front and rear doors for tube and furnace access—*Cleaver-Brooks Co., 326 E. Keefe Ave., Milwaukee 12, Wis.*

Packaged Air Conditioners . . .

. . . in 25, 30, 40, 50, and 60 ton models; equipped with 10 and 15 hp compressors and two-step thermostats or with four-step double thermostats—*Acme Industries Inc., 600 N. Mechanic St., Jackson, Mich.*

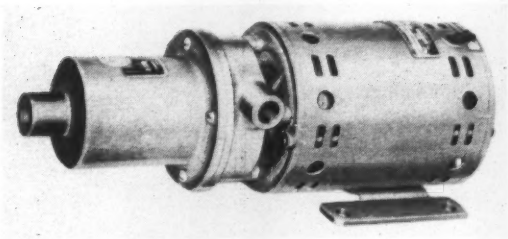


Pressure Pilots . . .

. . . for positive pressure to 30 in. Hg control, may also be used in process temperature control; accuracy said to be within ½ psi or ⅛ psi with larger diaphragms; air adjusted, available in variety of materials—*Spence Engineering Co., Inc., 32 Grant St., Walden, N. Y.*

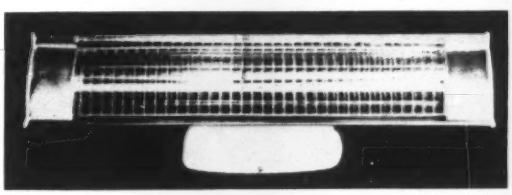
EQUIPMENT DEVELOPMENTS

Continued



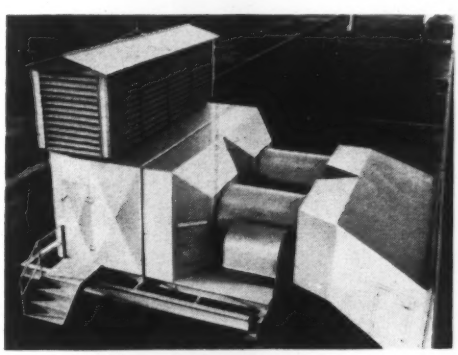
Centrifugal Pump . . .

. . . featuring stainless steel rotor and rubber stator; available with or without direct connected motors, in 24 models to 1200 gph maximum delivery; discharge heads to 300 psi.—*Robbins & Myers Inc., 1345 Lagonda Ave., Springfield, O.*



Infrared Heaters . . .

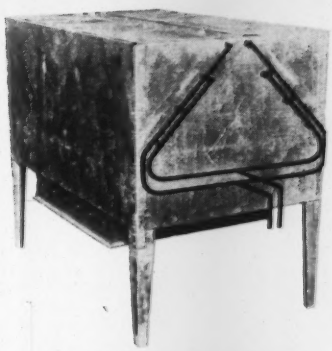
. . . of 450 and 1500 watts; heaters are 4½ in. wide and vary in length from 19½ to 44½ in.; feature moisture resistance and decorative face grilles—*Hanovia Lamp Div., Englehard Industries, 100 Chestnut St., Newark, N. J.*



Industrial Direct Fired Heater . . .

. . . supplies 150,000 cfm heated air with 15 million Btu per hr input burner; roof mounted unit supplies heated make-up air through registers via two axial flow fans, may be automatic or hand controlled—*Metals Engineering & Mfg. Co. Inc., Detroit 38, Mich.*

it's MARLEY for

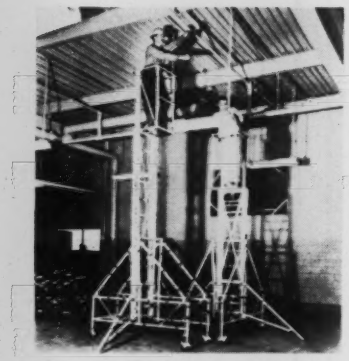


DRICOOLERS®
AIR COOLED
REFRIGERANT CONDENSERS

DriCoolers are of forced draft design that fully utilizes fan efficiency for effective cooling. Air discharge is vertical and unaffected by adverse currents; no hoods or shields are needed. DriCoolers are conservatively rated to insure full capability performance, ruggedly built to insure lasting performance. Mechanical equipment is heavy-duty industrial type; structurals and casings are of materials selected for sturdiness and durability. DriCoolers are designed for all-season service; the DriCooler automatic damper system (optional) makes operation in any climate positive, trouble-free and economical the year 'round. Sound level is exceptionally low. 9 models available.

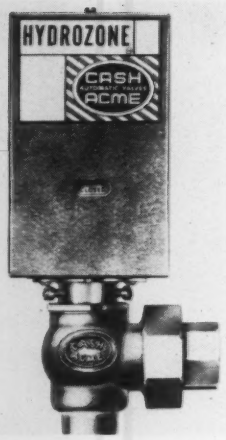
OTHER MARLEY PRODUCTS:
SPRATOWERS® . . . Natural Draft Towers
AQUATOWERS® and AQUACOOLERS® . . . Steel Cooling Towers for Outdoors or Indoors
PERMATOWERS® and WOOD AQUATOWERS® . . . Cooling Towers that resist corrosion

EQUIPMENT DEVELOPMENTS
Continued



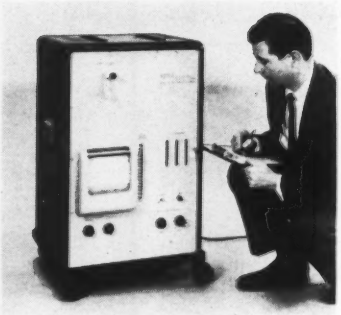
Telescoping Scaffolds . . .

. . . adjustable to heights of 31 ft; constructed of aluminum and equipped with wheels for easy movement in congested areas, 29 in. wide, can be assembled by one man—*Up-Right Scaffolds, 1013 Pardee, Berkeley, Calif.*



Control Valve . . .

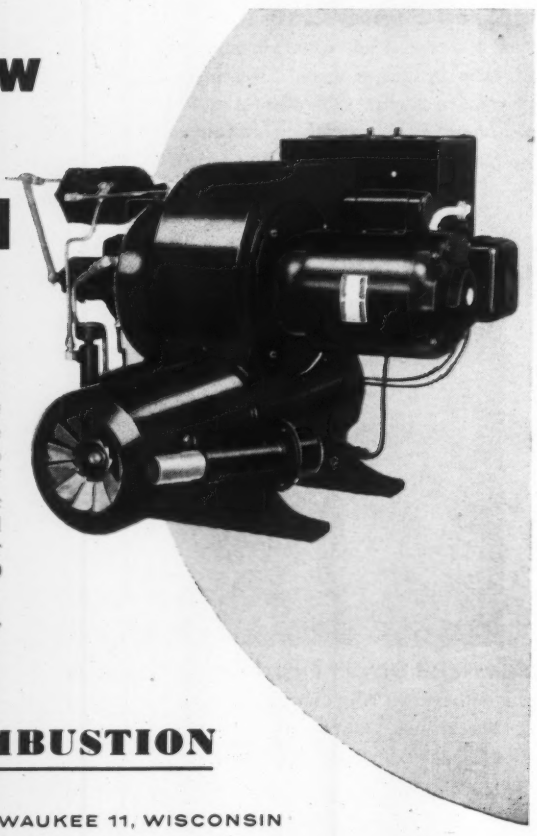
. . . motorized for use on hydronic systems and for up to 10 psi steam; available in ¾ in. sizes, larger sizes to come; features four body types and visual valve stem indicator; bulletin "1-Z-1" available on request—*Cash-Acme, P. O. Box 191, Decatur, Ill.*



Particle Monitor . . .

. . . for continuous outdoor-indoor monitoring of atmosphere; records aerosols from 0.3 microns to any desired upper limit with sequence recording of 15 sub-ranges; counting rate 1000 particles per min at flow rate of 100 cc per min, incorporates remote indicating alarm system, is self-calibrated—*Royco Instruments Inc., 365 San Antonio Rd., Mountain View, Calif.*

Keep heating costs low with HEV-E-OIL commercial-industrial burners



Hev-E-Oil burners furnish all the air necessary for combustion, assuring perfect fire control under all weather conditions. Low fire start that builds up gradually to the flame size required means smooth, safe operation. And once the burner is set for greatest efficiency, it *stays* that way no matter what the weather.

A complete package! Fire tested! Automatic, electronic controls. Meets all codes. Easy to install . . . Hev-E-Oil models from 5 to 150 gph. Also available, Hev-E-Duty power gas burners and combination gas/oil burners from 720,000 to 21,000,000 B.T.U.

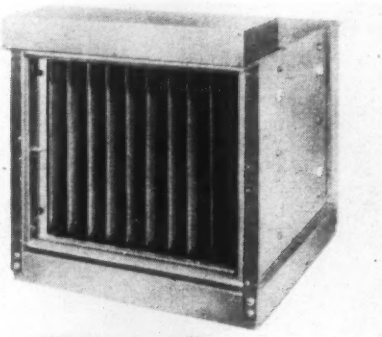
For more information write Industrial Combustion, Inc., 4507 N. Oakland Ave., Milwaukee 11, Wis., Dept. HPA-360

INDUSTRIAL COMBUSTION INC.

EXECUTIVE OFFICE: 4507 N. OAKLAND AVE., MILWAUKEE 11, WISCONSIN

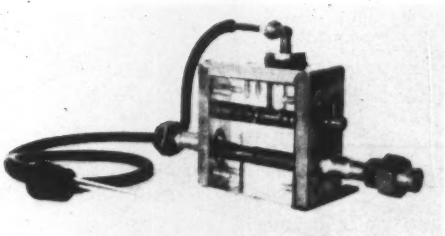
EQUIPMENT DEVELOPMENTS

Continued



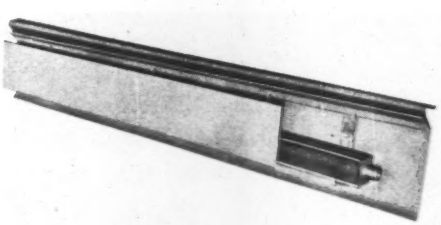
Electronic Air Cleaner . . .

. . . for high velocity systems; can be mounted overhead, with all high voltage leads from front of cabinet; available in six sizes, either field assembled or in cabinet units—*Dollinger Corp., 9 Centre Park, Rochester 3, N. Y.*



Liquid Feeder . . .

. . . for use on straight-line or by-pass runs; can be externally adjusted, will provide maximum 29 in. Hg vacuum; available in special alloy for corrosive liquid feed—*Mader Machine Co., 1111 W. 13th St., Lorain, O.*



Radiant Baseboard . . .

. . . for hydronic installations; equipped with corner expansion tracks and mechanical damper, available in 2 to 20 ft lengths—*Embassy Steel Products Inc., 890 Stanley Ave., Brooklyn 8, N. Y.*

For Commercial Installations

Independent famous "Fabrikated" construction makes these grilles especially adaptable to large sizes for schools, hospitals, hotels, and other commercial buildings.

CHECK THESE FEATURES

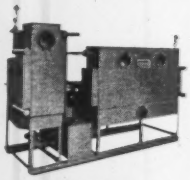
- Vertical or horizontal bars strengthened by interlocking cross bars; no vibration.
- Tamper-proof. Changes in air distribution cannot be made by unauthorized persons.
- Mesh (3/4 x 1 1/4) filters 72% of free area yet darkens the duct and reduces highlights from back of the grille.
- 14 gauge steel solid bars 1/2" deep—strong enough to be "kick-proof"—(a must for schools).
- All bars made from round edge stock. No sharp edges. (A must for schools).
- The only grille for taking abuse in school gyms and hospital psychopathic wards.

These grilles are unusually rigid-strong and exceedingly resistant to impact—the best that money can buy. We make them in any size. Send your specifications. We are prepared to give immediate service because we always stock grille parts for any size.

THE INDEPENDENT REGISTER CO.
3747 E. 93rd STREET · CLEVELAND, OHIO

NEW DURABLE KATHABAR® SYSTEMS

offer high performance with new low maintenance for years of troublefree service



LOW MAINTENANCE

Rugged new Kathabar design provides all-nickel regenerator, separate from rest of system, to prevent condensation corrosion. Breaking all records for low maintenance, all over the world.

WIDE USAGE

Successfully applied in wide range of industries, hospitals, buildings. Easily provide conditions of 80° F and 35% RH to 30° F and 10% RH. Deliver air at -90° F dew point.

ENGINEERS LIKE

Consulting engineers like the Kathabar system: no re-heat, no frost, no chemical carryover. Humidity, independent of dry bulb, controlled with no reversing or interruption for regeneration.

GET FACTS

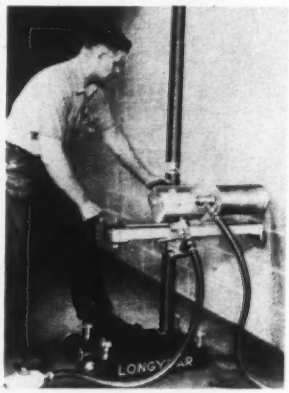
SURFACE COMBUSTION
A division of Midland Ross Corporation
2384 Dorr Street, Toledo 1, Ohio
Send facts on Kathabar systems for following application:

.....
name & title .....
company .....
street .....
city ..... *zone* ..... *state* .....

59-7

In Europe: NEDAIRCO, The Hague. In Japan: CHUGAIRO, Osaka.

EQUIPMENT DEVELOPMENTS
Continued

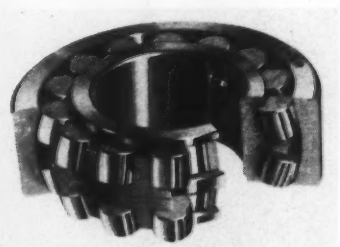


Diamond Drills . . .

. . . for use on concrete, tile, stone, other hard or brittle material; of 6 in. capacity, air or electric drive optional, swivel mounted to drill at any angle; screw feed furnishes mechanical advantage for easy operation—*E. J. Longyear Co., 76 S. 8th St., Minneapolis 20, Minn.*

Beam Clamp . . .

. . . for securing switches, pipes, to I-beams; for ¾ in. channels, I-beam members, may be fastened in any position, mounts flush for use above false ceilings—*The Paine Co., 38 Westgate Rd., Addison, Ill.*



Roller Bearings . . .

. . . of convex design with double row of rollers and single spherical outer raceway; firm offers spherical bearings in five sizes; bulletin "113" available upon request—*Hoover Ball and Bearing Co., 5400 South State Rd., Ann Arbor, Mich.*

Keflex Manufacturing Division
U. S. Flexible Metallic Tubing Co.
Since 1905

KEFLEX

LAMINATED
STAINLESS STEEL BELLOWS

General Offices — 63 Main St., San Francisco 5, Calif.
Factories — Los Angeles — San Francisco
Sales Offices — Agents in Principal Cities of U. S. and Canada

KEFLEX QUADRA-SIDE EXPANSION COMPENSATORS

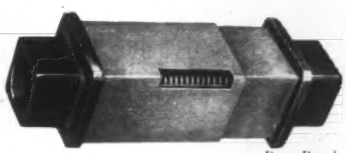
FOR STEAM AND HOT WATER HEATING SYSTEMS
USED WITH CONVECTOR AND FIN TUBE BASEBOARD RADIATION UNITS
IN SCHOOLS, HOSPITALS, OFFICES AND COMMERCIAL INSTALLATIONS

TYPE 7 Q square brass telescoping case protects laminated stainless steel bellows from torsion, squirm, misalignment and external damage. Compensators are used in high and low pressure hot water supply lines, risers and for baseboard radiation. Extra flexibility provides maximum cyclic life. Units are very compact and rugged. Sizes ¾" thru 3". Pressures to 300 PSI. Temperatures to 800°F. Traverse: Single Units, total 2" (1-½" compression, ½" extension) Dual units available.

TYPE 11 Q-T has heavy square telescoping case and laminated stainless steel bellows. For use in risers and with baseboard radiation. Test pressure 150 PSI, working pressure 100 PSI, temperatures to 300°F. Traverse: Total 1" (¾" compression, ¼" extension).

TYPE 7 Q WITH BRASS FEMALE THREADED ENDS

Working Pres. 300 PSI Maximum
Temp. 800 F

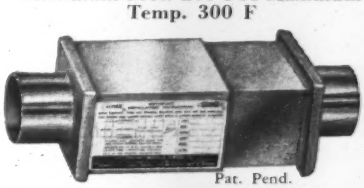


Pat. Pend.

Nom. I.P.S.	Overall Length	Max. O.D.	Wt. #
¾"-1.00"-1.25"	6.50"	2.00"	2
1.50	6.50	2.50	4
2.00	6.50	3.00	5
2.50	6.50	3.50	6
3.00	6.50	4.00	9

TYPE 7 Q-T WITH COPPER TUBE ENDS

Maximum Pres. 200 PSI Maximum
Temp. 300 F



Pat. Pend.

To Fit Copper Tubing Nominal I.D.	To Fit Copper Tubing Actual O.D.	Overall Length	Max. O.D.	Wt. #
¾"	7/8"	6.50"	2.00"	1½
1	1⅛	6.50	2.00	1½
1¼	1⅜	6.50	2.00	1½
1½	1⅝	9.00	2.50	3½
2	2⅛	10.00	3.00	4½
2½	2⅝	10.75	3.50	5½
3	3⅛	11.50	4.00	8¼

TYPE 11 Q-T WITH COPPER TUBE ENDS

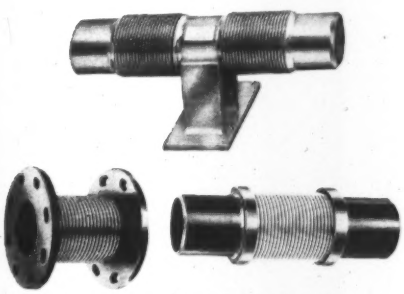
Maximum Pres. 100 PSI Maximum
Temp. 300 F

Pat. Pend.

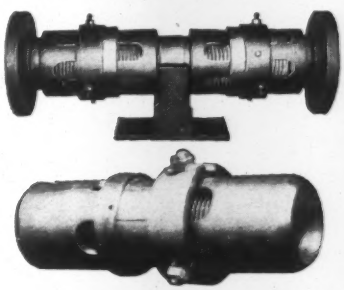
To Fit Copper Tubing Normal I.D.	To Fit Copper Tubing Actual O.D.	Overall Length	Max. O.D.	Wt. #
¾"	7/8"	4.50"	1.50"	1¼
1	1⅛	4.50	1.50	1¼
1¼	1⅜	4.50	1.75	1½
1½	1⅝	4.50	2.25	3
2	2⅛	4.50	2.75	4

EXPANSION JOINTS—VIBRATION ABSORBERS—FLEXIBLE CONNECTORS—PIPE GUIDES

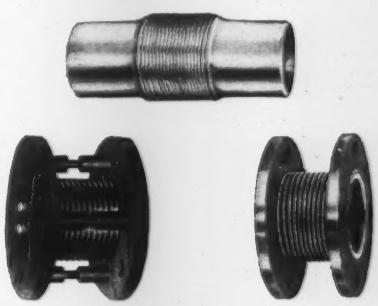
Force Required to Compress Keflex Expansion Joints Their Full Rated Traverse is Usually Less Than 100 Lbs., Total



KEFLEX EXPANSION JOINTS — corrugated, packless type for steam and hot water heating systems and process piping. Laminated stainless steel bellows with internal liner guides and stainless steel contour control rings. Weld ends, or flanges. Outside shrouds and intermediate anchor bases available. Sizes 2" through 48". Pressures 70 to 450 PSI. Temperatures to 800° F. Furnished for various required traverses.

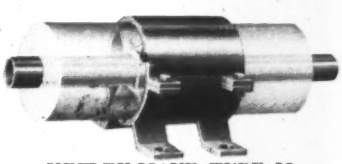


KEFLEX-KETROL CONTROLLED EXPANSION JOINTS — positive protection against torsion. For use in pipe lines to compensate for expansion and contraction. Shroud has intermeshing fingers providing concentric guiding and protection against squirm, torsion, and external damage to laminated stainless steel bellows. Designed for high pressure, high temperature hot water service. Movement is controlled by limit stops. Sizes 2" through 48". Pressures to 450 PSI and temperatures to 800° F.



KEFLEX FLEXIBLE CONNECTORS AND VIBRATION ABSORBERS — to absorb vibration from pumps, chillers, and compressors. Serves to relieve stress on pump volute when piping is misaligned. Extra flexibility of laminated stainless steel construction produces long cyclic life. Compact units save space and are easy to install. Available with or without tie rods. Sizes 2" through 48". Pressures to 450 PSI and temperatures to 800° F.

Modified Types are available for special conditions requiring higher pressure, temperatures, traverse, or combination deflections.



KEFLEX-MAVE TYPE M

Fabricated steel pipe guides for concentric guiding of pipe lines. Special insulated guides are available for chilled water.

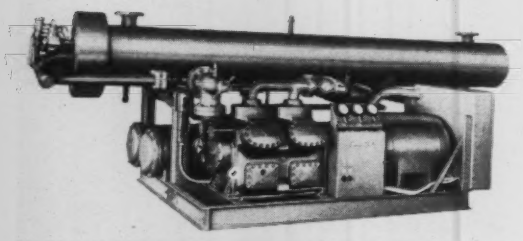
FLEXIBLE "BMH" CONNECTORS

"USF" BRONZE VIBRATION ABSORBERS

Braided bronze Metal Hose assemblies made in standard lengths. Usually used as flexible connectors on pumps and other mechanical equipment for heating and air conditioning service. Available with threaded male ends, flanges, and copper tube sweat ends.

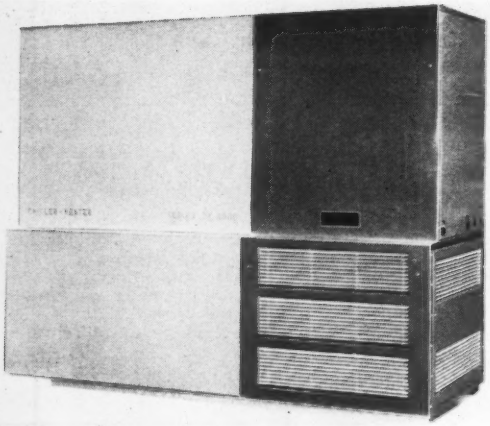
EQUIPMENT DEVELOPMENTS

Continued



Packaged Liquid Chillers . . .

. . . direct drive and semi-hermetic; sizes range from 75 to 125 hp for direct drive compressors, 7½ through 60 hp drives on semi-hermetic compressors; feature matched components, shipped completely assembled. installation requires only control setting, adding refrigerant, water, and power connections—*Curtis Mfg. Co., Refrigeration Div.*, 1905 *Kienlen Ave., St. Louis* 33, *Mo.*



Absorption Heat Exchanger . . .

. . . direct-fired gas with 400,000 Btuh hot water and 300,000 Btuh chilled water capacity; employs water as refrigerant and lithium bromide for absorbent, operates by changing pressure levels within factory sealed system, features conveniently located service connections for parallel installation—*Arkla Air Conditioning Corp.*, 812 *Main St., Little Rock, Ark.*

FIRST and ONLY FIRE DAMPER

TO RECEIVE THE UNDERWRITERS' LABORATORIES APPROVAL

(Based on a 1½ hour test)

This acceptance by the UNDERWRITERS' LABORATORIES came only after extensive tests with FIRE DAMPERS constructed according to the present Bulletin No. 90 SERIES, which failed to pass the test, and the IMPERIAL DAMPER No. VWNYT-1, which passed the test, and now carries the UNDERWRITERS' LABORATORIES LABEL.

We, also, at this time, proudly announce the APPROVAL AND LABELING of the IMPERIAL DAMPER No. VWNYT-1 by the BOARD OF STANDARDS AND APPEALS FOR USE IN NEW YORK CITY. This is the FIRST AND ONLY DAMPER to date to carry this approval and label.

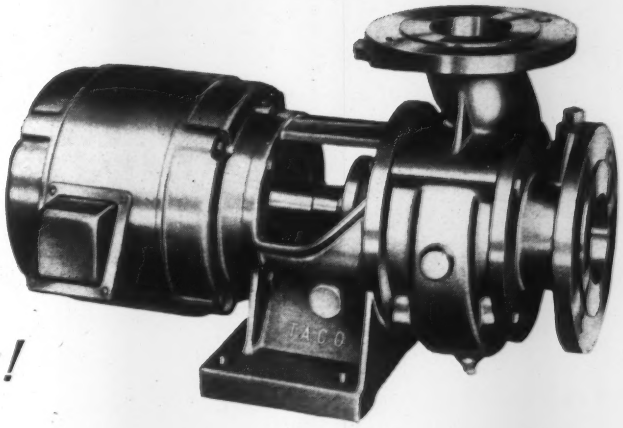
Send for Our New Informative Brochure!

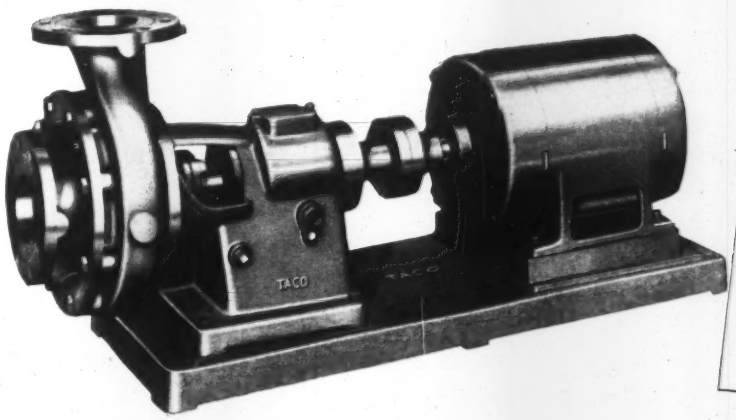
IMPERIAL DAMPER COMPANY

Manufacturers of Volume Dampers, Multi-Blade Dampers, Automatic Dampers, Automatic Shutters, Back-Draft Shutters, Louvers, Stationary and Adjustable Extruded Aluminum Louvers.

664 EDGECOMBE AVENUE
NEW YORK 32, N. Y.
LORRAINE 8-9100

Now... the pump line with total range efficiency!





Standardized Line... Special Capabilities

- Highly Standardized Component Parts
- Self-Venting Centerline Discharge
- Mechanical Seals or Stuffing Boxes
- Ball or Sleeve Bearing Frame
- Stainless Steel Shaft Sleeves
- Casings Adaptable to Horizontal Discharge
- Available with EXTRA Quiet Motors

TACO "LP" *Single Stage Centrifugal Pumps*

High overall efficiency throughout its entire usable range is a basic characteristic of every TACO "LP" Series Pump. And the *complete selection* of sizes available gives *complete* coverage . . . permits each pump to be precisely tailored to the installation. As a result, you're *certain* of better performance when you specify an "LP" . . . and can often save on motor cost and power consumption.

Many of the outstanding advantages of the "LP" line are the result of their "preferred number" design (ASA Standard No. Z 17.1). Using it, TACO was the first manufacturer with a line of pumps uniformly designed and engineered to provide the broadest possible performance field with the minimum number of pumps. It gives consulting engineers and contractors pump versatility and quality that they can specify with confidence.

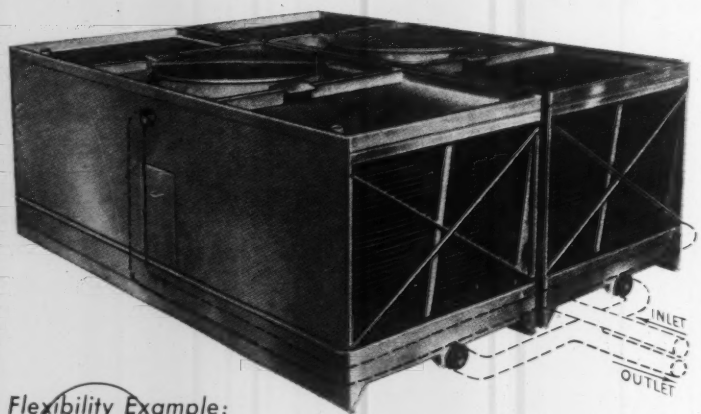
TACO also manufactures a complete line of smaller pumps and circulators for air conditioning and heating installations. Get complete specifications in time for your next installation.

Write TACO HEATERS, INCORPORATED, 1160 Cranston Street, Cranston 9, Rhode Island.

Taco

SERVING THE HYDRONIC INDUSTRY SINCE 1920

Havens
COOLING TOWERS GIVE YOU FLEXIBILITY



Flexibility Example:
Two 100 Ton Units Side by Side with Suggested Piping Method.

"VM" SERIES SHIPPED PRE-ASSEMBLED
Achieve Large Tonnage Installation Easily by Adding Additional Towers

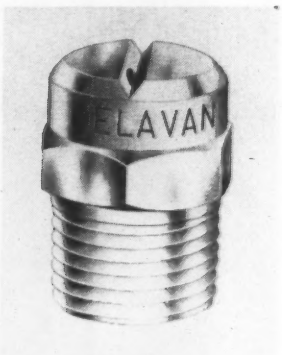
Havens offers maximum flexibility with pre-assembled packaged cooling towers that **incorporate internal piping.** Large tonnage installations can be accomplished easily and at a big savings by using additional towers. Havens "VM" Packaged Towers are available in 80-100-125 and 150 ton sizes. Other capacities and styles also available.

HAVENS TOWERS FEATURE:

- **Shipped assembled ready for hoisting, piping and wiring**
- **Easily detachable hoisting yoke eliminates elaborate slings for hoisting**
- **All steel construction—hot-dipped galvanized after fabrication**
- **All heart California redwood fill**
- **Low silhouette**
- **Anti-friction ball bearings equipped with moisture barrier seals**
- **Open gravity type distribution with drilled orifices and overflow standpipe**
- **Simple installation**

Write for Literature
Havens COOLING TOWERS
Division of
HAVENS STRUCTURAL STEEL COMPANY
1713 Crystal Avenue, Kansas City 26, Missouri

EQUIPMENT DEVELOPMENTS
Continued

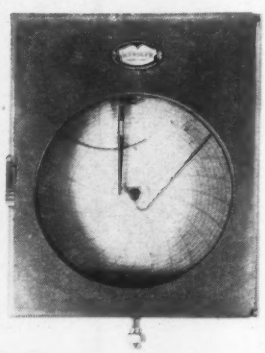


Plastic Nozzles . . .

. . . of polyvinyl chloride for flat spray industrial requirements; available in 1/8, 1/4, 3/8, 1/2, and 3/4 in. male pipe threads; catalog "33" available on request—*Delavan Mfg. Co.*, 811 *Fourth St., West Des Moines, Ia.*

Tubing Tools . . .

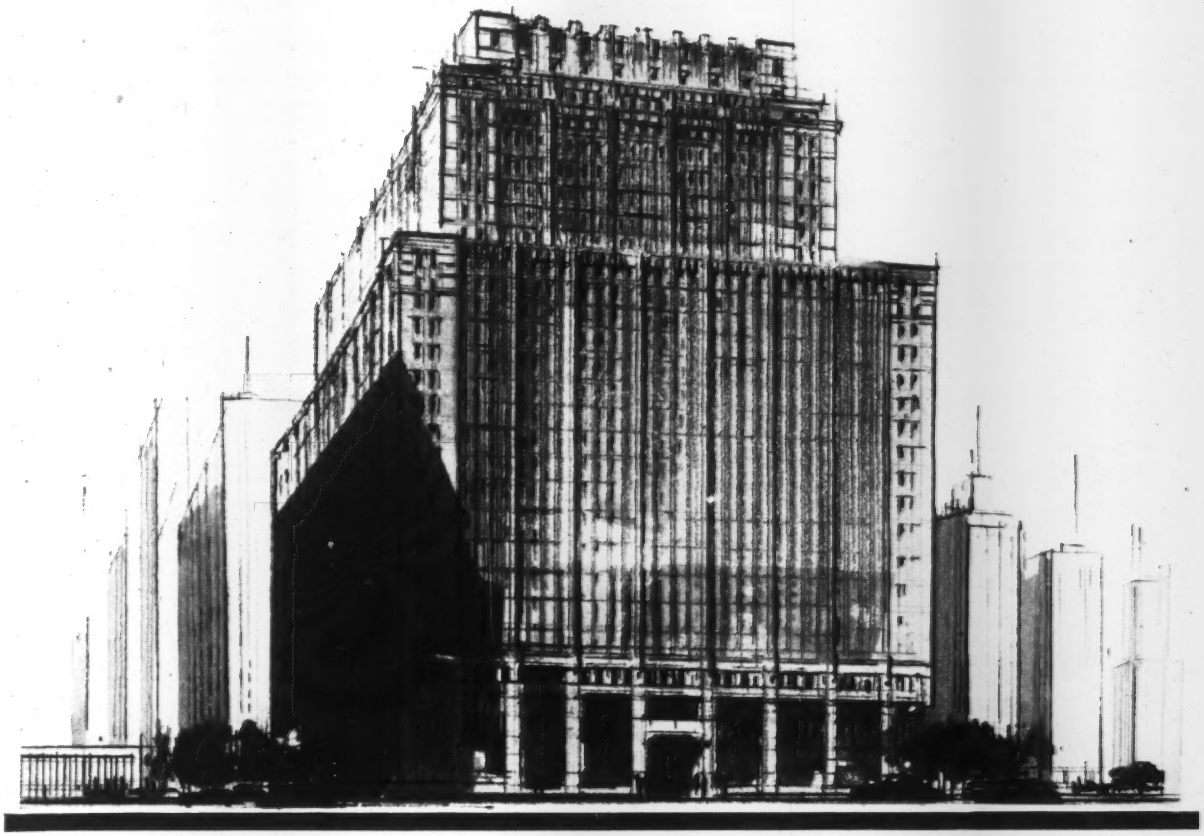
. . . including cutters, flaring and swaging tools, benders; for copper and brass—*The Toledo Pipe Threading Machine Co.*, 1145 *Summit St., Toledo, O.*



Indicating Recorders . . .

. . . for temperature, pressure, humidity recording; available with 8 in. chart for one to three pens or 10 to 12 in. chart for one to four pens; hand-wound or electric chart drives for up to 31 day revolution—*Weksler Instruments Corp.*, 195 *E. Merrick Rd., Freeport, L. I., N. Y.*

Climate by Chrysler



2 Park Avenue, New York City. Consulting Engineers: Sears and Kopf; Mechanical Contractor: Kennedy-Scheidel-Young, Inc.; Electrical Contractor: Theodore Kaish, Inc.

Chrysler Air Conditioning tailored to tenant needs installed a floor at a time in 27-story building

During the past five years, scores of Chrysler air conditioners have been installed at 2 Park Avenue, New York City. What has been one of the longest air conditioning jobs in history has also been one of the most successful.

By handling this 27-story building zone by zone and floor by floor, about 1400 tons of Chrysler equipment have been installed . . . with an absolute minimum of inconvenience to tenants. As tenants move in or renew leases, they are consulted as to exact air conditioning requirements. Each then gets the system best suited to his needs.

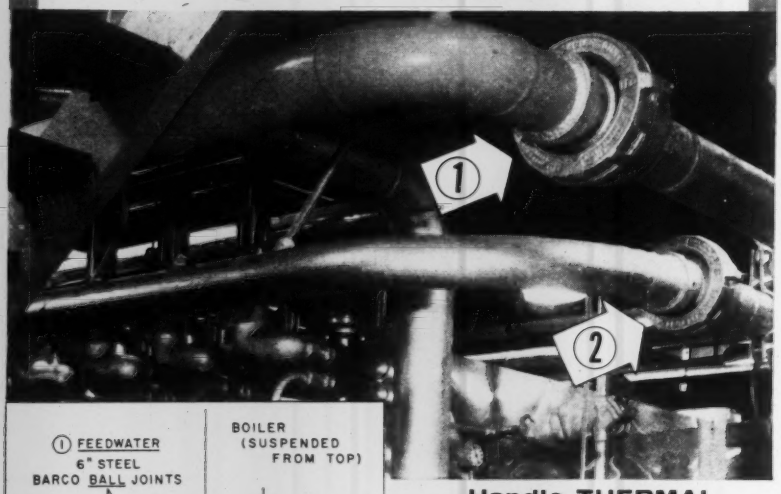
This unusual method is flexible—Chrysler can supply packaged units, chillers or room units as needs demand. And it is economical—all air conditioning equipment taps into central electrical, water and air connections which serve the entire building.

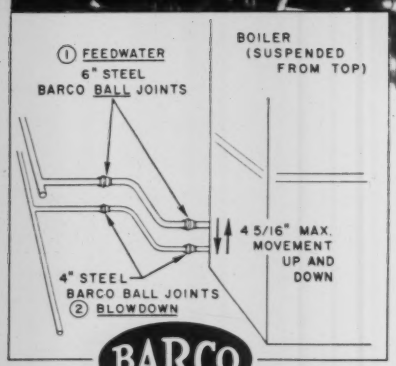
Chrysler engineers worked closely with the consulting engineer and contractor during the advance planning of this complex air conditioning problem. They will be as happy to cooperate with you. For information on their services and Chrysler Air Conditioning equipment, write today.

CHRYSLER AIRTEMP

Airtemp Division, Chrysler Corporation, Dept. Y-30, Dayton 1, Ohio
In Canada: Therm-O-Rite Products, Ltd., Toronto, Ontario

. . . where BOILERS move UP and DOWN





BARCO

Handle THERMAL EXPANSION with BARCO Ball Joints

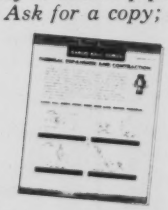
The schematic diagram at left shows how Barco Flexible Ball Joints of steel construction are used in a new Florida utility plant—design pressure 600 psi, 500 F. The above photo shows a close-up view of two of the joints (see arrows). Two more matching joints, 4" and 6", are located out of the picture to the left. The 4" joints have metal gaskets. The same utility also uses 10" Barco joints on gas fuel lines. Other uses in power plants are for flexible connecting lines to oil burners, soot blowers, and other auxiliary equipment.

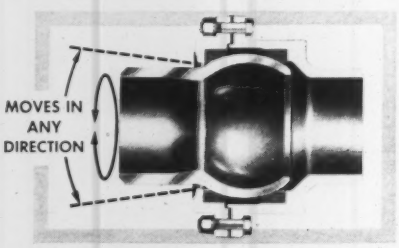
Solves Piping Problems!

The rapidly increasing use of Barco Flexible Ball Joints for solving piping problems in POWER PLANTS is significant for several key reasons:

1. Substantial *space saving* as compared to other methods in crowded piping areas.
2. Unlimited flexibility and movement. Utmost simplicity.
3. No heavy pipe anchoring required. No "end thrust" developed under pressure.
4. Ability to handle compound movement (where twisting is combined with thermal expansion and contraction).
5. Easy to engineer joints into piping to provide for any degree of flexibility, expansion, or movement required.
6. Maximum safety for high temperature applications. All-metal construction available. Special alloys can be specified.
7. Basic design is pressure sealing against leakage and self-adjusting for wear.
8. Virtually no deterioration. Able to stay in service for years without repairs or maintenance. No lubrication.

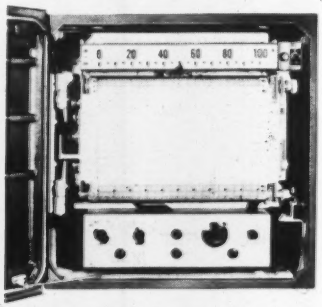
New Bulletin No. 31 contains interesting diagrams showing how to solve many common pipe expansion problems EASILY, ECONOMICALLY. *Ask for a copy;* see your nearest Barco representative or write:





BARCO MANUFACTURING CO.
541D Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

EQUIPMENT DEVELOPMENTS
Continued

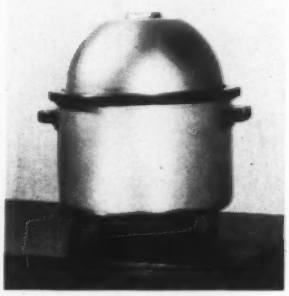


Potentiometer Recorder

. . . for pressure, temperature, motion, flow, density, pH, and electrical measurement; has four position input selector and five position span selector with automatic standardization feature optional, also optional attachments for chart drive and pen control —*The Bristol Co., Waterbury 20, Conn.*

Plastic Filters . . .

. . . for commercial and industrial use; polyester fabric employs "electrostatic" principle to improve dust pick-up, is unaffected by humidity or temperatures to 230 F, and resists shrinkage, according to manufacturer —*Stoddard Industries Inc., 3383 E. Layton Ave., Cudahy, Wis.*



Atomizing Humidifier . . .

. . . for use in spaces up to 8000 cu ft; portable unit atomizes water at rate of 1 pint per hr by centrifugal force into 5 to 10 micron particles— *Skuttle Mfg. Co., Milford, Mich.*

Armstrong announces Armaflex 22 —a new, improved pipe insulation

An improved flexible foamed plastic pipe covering, with a broader temperature range and a super-smooth surface finish, has been developed by Armstrong.

This easy-to-apply insulation can be used on hot lines operating up to 220° F., as well as on all cold piping at temperatures down to zero and below. The new, smooth surface gives every installation a neatly finished look.

In addition to being an efficient insulator, Armaflex 22 has high resistance to water and vapor penetration, is self-extinguishing, ozone resistant, and has negligible odor.

Armaflex 22 is made in 6-ft. lengths, in $\frac{3}{8}$″, $\frac{1}{2}$″, and $\frac{3}{4}$″ wall thicknesses for pipe and tubing from $\frac{3}{8}$″ to $3\frac{1}{8}$″ i.d.

For free booklet on Armaflex 22, write Armstrong Cork Company, 2203 Sherman Street, Lancaster, Pa.

COMPARISON CHART

Here's how the physical properties of Armaflex 22 compare with other flexible foamed plastic pipe coverings.

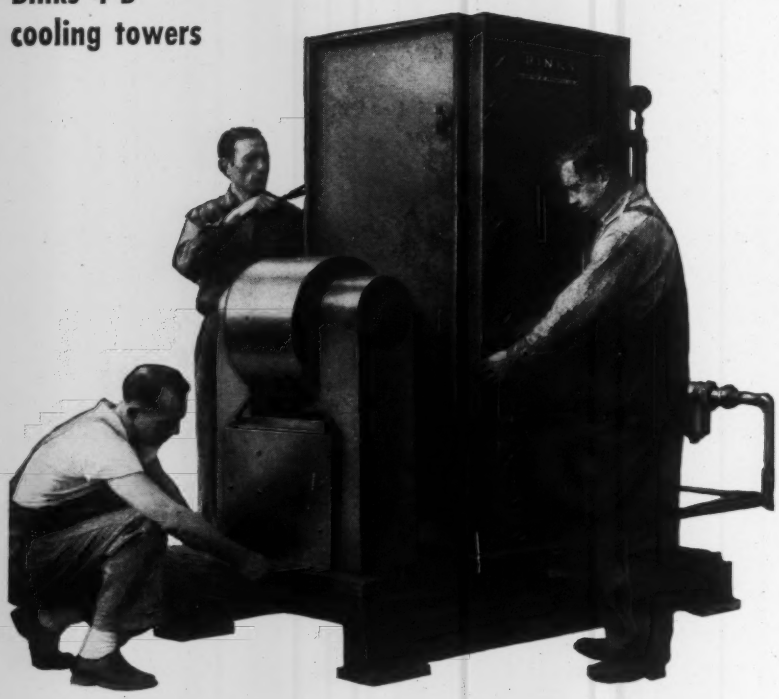
Physical Properties	Armaflex 22	Brand A	Brand B	Brand C	Brand D
Low Density less than 7.5 lb./cu. ft.	Yes	No	Yes	Yes	Yes
Low Water Vapor Transmission less than .15 perm	Yes	No	No	Yes	No
Low Water Absorption less than 3% by volume — 28 days	Yes	No	No	Yes	Yes
Dimensionally Stable at 220° less than 5% lineal shrinkage — 28 days	Yes	No	No	No	No
Dimensionally Stable at 200° less than 5% lineal shrinkage — 28 days	Yes	Yes	Yes	No	No

Properties evaluated at Armstrong Research and Development Center

Armstrong INSULATIONS

1860-1960 Beginning our second century of progress

Binks 4-B cooling towers



hot-dipped galvanized after fabrication for years more service

Now . . . Binks adds extra years of life to an already rugged, dependable cooling tower.

New 4-B series

Now . . . blowers, tower casings, basin . . . all parts subjected to corrosive action, weather and temperature changes are hot-dipped galvanized *after they are fabricated.*

No paint . . . no other coating material offers such long-lasting positive protection. And . . . hot-dipping after fabrication insures that there is no break in this protective armor.

High performance

Season in and season out, Binks towers are always more than a match for the specified cooling load. Motors, whisper-quiet squirrel cage blowers, decking and water dispersal ratios are all properly balanced for top efficiency.

Get complete specifications Ask for Binks Bulletin 478. Contains dimensions, capacities and other specification and performance data.

Binks *EVERYTHING FOR WATER COOLING*

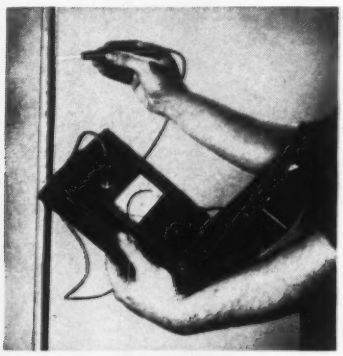
A COMPLETE LINE OF NATURAL DRAFT AND MECHANICAL DRAFT COOLING TOWERS AND INDUSTRIAL SPRAY NOZZLES

Binks Manufacturing Company
3118-38 Carroll Ave., Chicago 12, Ill.

REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

EQUIPMENT DEVELOPMENTS

Continued

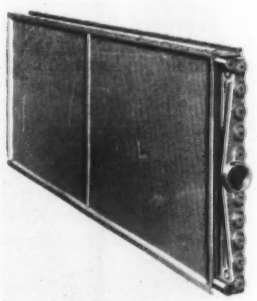


Electrical Thermometer . . .

. . . for laboratory or production line applications; operates by means of ½ in. diam probe from −4 F to +356 F range for temperature measurement of solids or liquids—*Ameresco Inc., 7 Center Ave., Little Falls, N. J.*

Welding Gun . . .

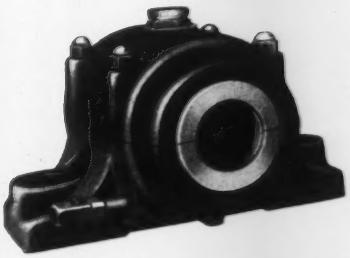
. . . for use on mild steel with CO_2 shielding gas; rated at 600 amp d-c, gun can accommodate welding wires to 3/32 in.; equipped with lever type trigger and goose-neck nozzle assembly—*Air Reduction Sales Co., Inc., 150 E. 42nd St., New York 17, N. Y.*



Heat Exchanger . . .

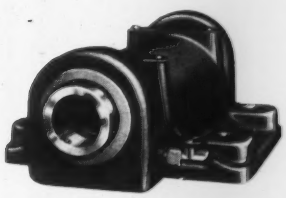
. . . of fin-and-tube design said to be 40 percent smaller, for steam, hot water, booster, and steam distributing applications; has cast iron headers and galvanized casing—*The Trane Co., La Crosse, Wis.*

QUIET



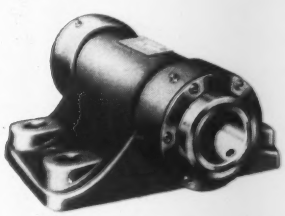
DODGE SLEEVOIL PILLOW BLOCKS

Exceptionally quiet in operation. Noted for superb quality. Plain and Water Cooled Types. Precision-built, ring-oiling, babbitted. Self-aligning. Can be drilled for thermostatic emergency warning. Shaft sizes from 1-7/16" to 10".



DODGE BRONZE BUSHED PILLOW BLOCKS

Designed for Arrangement No. 2 installations. Two bronze bushings of high lead content mounted in one cast iron housing. Special T-section rings for dependable lubrication. Exceptionally quiet in operation. Shaft sizes from 15/16" to 2-3/16".



DODGE BALL BEARING PILLOW BLOCKS

Designed for Arrangement No. 2 installations. Two precision single row, deep groove ball bearings in one cast iron housing. Extended inner race carries shaft. Remarkable ease of installation and maintenance. Shaft sizes from 15/16" to 2-3/16".

These quality bearings have been developed in close cooperation with manufacturers of fan and blower equipment — to meet the highly specialized requirements of this field.

The nation's great generating plants choose these bearings because of their extraordinary dependability—and the extreme quietness of their operation makes them top choice for air conditioning systems in hospitals, schools, theatres, auditoriums.

Dodge Fan and Blower Bearings are available from stock—with stock-product economy. Consult your local Dodge Distributor—or write us for technical data.

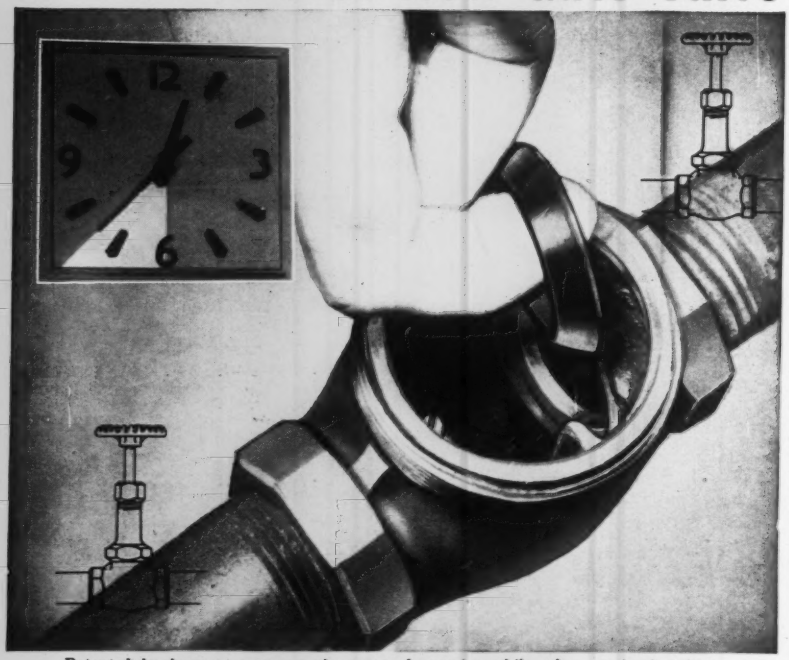
DODGE MANUFACTURING CORPORATION
1600 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

MANUFACTURER OF AMERICA'S MOST COMPLETE LINE OF MOUNTED BEARINGS

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

Only 7 to 10 Minutes to Renew Service Life of New Gate Valve



Patented development assures replacement of seat ring while valve remains installed.

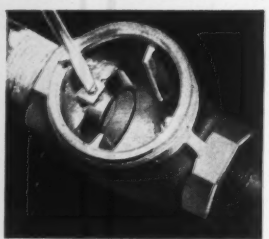
Without removing the valve body from the line, you replace the nickel-alloy seat rings in Fairbanks new patented Renewable Seat Ring Gate Valves. In 7 to 10 minutes, from the time the line is shut down until it is put back into operation, you have given a new service life, a new life of dependable tight closure to your valve.

Just 7 to 10 minutes of your maintenance man's time — only 7 to 10 minutes of "down-time" on your steam, water or process piping lines — and you have the equivalent of a new valve in the line. Think of the savings: where once at least one hour, under the most ideal conditions, was required to replace a gate valve in the line, the job is now accomplished in from 7 to 10 minutes.

Field tested for over two years, under all conditions from steam to corrosive liquids, the revolutionary new Fairbanks Renewable Seat Ring Bronze Gate Valve has proven completely satisfactory — absolutely dependable.

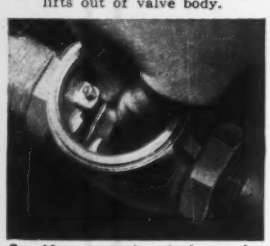
Made with either rising stem or non-rising stem construction in ½", ¾", 1", 1¼", 1½" and 2" sizes, the Fairbanks Renewable Seat Ring Bronze Gate Valves are recommended for severe service conditions on 200 lb. steam pressure at 550 degrees F., 400 lb. water, oil or gas pressure — non-shock — lines requiring full flow and subject to frequent operation. Nickel alloy seat rings and wedge make the valves particularly tough and corrosion resistant.

YOURS ON REQUEST: Illustrated, descriptive folder gives complete information on Fairbanks Renewable Seat Ring Gate Valve with details and specifications. Yours without charge. Write today.



1. Union Bonnet removed. Retaining screw loosened with ordinary screwdriver.

2. Finger hooks inside nickel alloy seat ring. Seat ring lifts out of valve body.



3. New seat ring is inserted. Retaining screw tightened. Bonnet replaced.

THE **Fairbanks** COMPANY
393 Lafayette Street, New York 3, N. Y.
Branches:
New York 3 • Boston 10 • Pittsburgh 22 • Rome, Ga.
Valves • Trucks • Casters • Wheels • Dart & "PIC" Unions

EQUIPMENT DEVELOPMENTS
Continued

Electronic Sentry . . .

. . .for refrigeration and air conditioning systems; signal light indicates equipment failure or inefficiency; consists of sensing probe located in liquid line of system, operates on 60 cycle, 115, 208, or 230 v a-c—*Televance Corp., P.O. Box 3043, St. Louis 23, Mo.*

Electrostatic Deodorizer . .

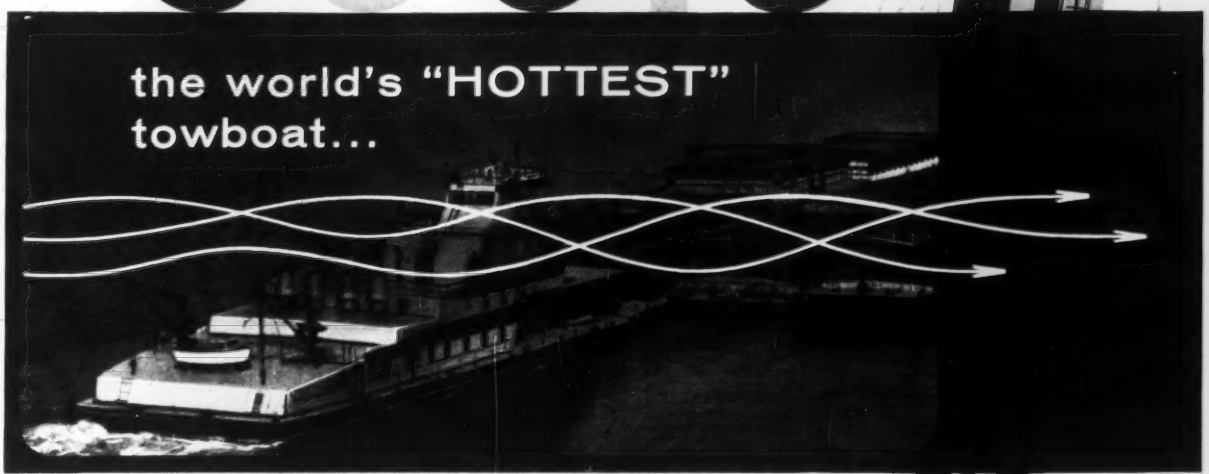
. . .in sizes suitable for institutional and industrial plant use; according to manufacturer, unit rids area of odors without relieving ozone to space; uses current approximately equal to 75 watt light bulb—*Morris Deodorizers Inc., 2819 Broadway N. E., Knoxville 17, Tenn.*

Insulation Cement . . .

. . .can be applied in a variety of ways to shaped or plane surfaces or pre-molded for pipe jackets; said not to shrink and is non-corrosive to metals, set or dried can be re-used; brochure available on request—*Thermold Products Co., Grandview, Mo.*

Curtis COOLS

the world's "HOTTEST" towboat...

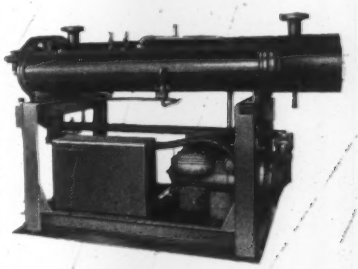


Huge 180 foot Federal Barge Lines towboat, the United States, has 50% greater horsepower than the largest towboat on the rivers. It can push 40 barges, totaling 1/3 mile, or 300 ft. longer than the "Queen Elizabeth".

C-100

Space saving design versatility? Easy installation? Operating dependability? Comparative cost? All these factors were considered by St. Louis Shipbuilding and Steel Company in the selection of air conditioning equipment for the world's most powerful towboat. The shipbuilders' and their design engineers' careful choice? A Curtis 20-ton packaged liquid chiller system. This equipment will cool the crew's quarters, galley, mess room, officers' and guest quarters—all with individual room or area temperature control.

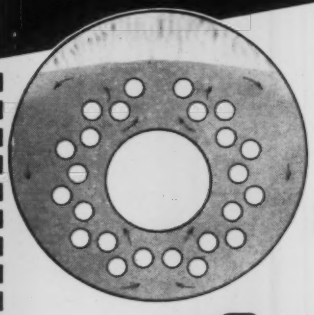
The Curtis complete line, and reputation for dependability in installations of all types, work to the benefit of engineers and mechanical contractors. Factory run-in of all units cuts call backs far below average. You can safely promise dependable performance always up to, and frequently surpassing, rated capacity. You eliminate your problems when you specify Curtis, because you're working with an outstanding manufacturer of air conditioning equipment.



THE COMPLETE LINE OF LIQUID CHILLERS • PACKAGED AIR CONDITIONERS • CONDENSING UNITS

Curtis MANUFACTURING COMPANY • REFRIGERATION DIVISION • *ESTABLISHED IN 1854* *St. Louis 33, Missouri*

rapid, natural water circulation



2-PASS DESIGN...

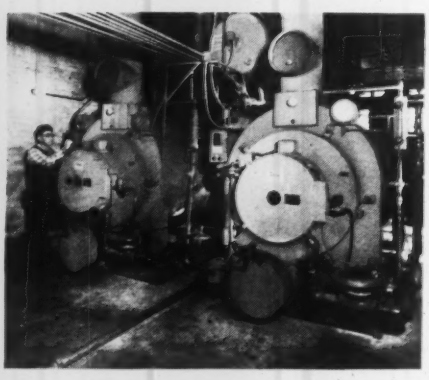
Continental AUTOMATIC BOILERS

One of the important advantages of the *Continental* 2-Pass design is the large diameter combustion tube providing maximum heat release volume, surrounded by concentric location of tubes in the water circulation path to eliminate accumulation of any insulating gas pockets. Large clearances are provided between tubes and combustion chambers as well as between tubes and outer shell. This assures unimpeded rapid water circulation down around the shell and up around the furnace.

Other *Continental* features make this 2-Pass Automatic Boiler the one boiler with the most practical and economical approach to heat transfer of all packaged boilers today... Write today on your company letterhead for latest data designed to show how you can save with a *Continental*.

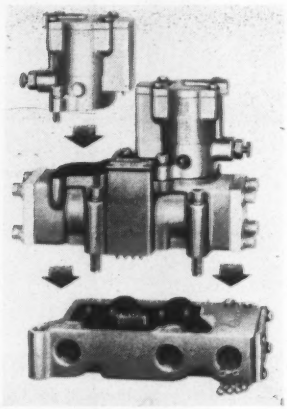
NEW CONTINENTALS– NEW SAVINGS

Two new 90 hp. *Continental* 2-Pass Automatic Boilers installed in industrial plant for economy in heating, reduced maintenance costs.



CONTINENTAL BOILER Division
BOILER ENGINEERING & SUPPLY CO., Inc.
Phoenixville, Pennsylvania

EQUIPMENT DEVELOPMENTS
Continued

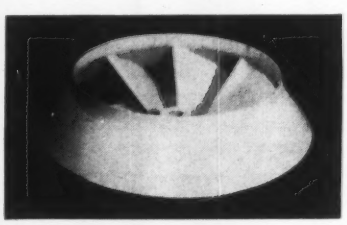


Control Valves . . .

. . . pilot-operated, in ½ in. single and double solenoid plug-in types; incorporate one-piece pilot housings and aluminum bodies and sub-bases, stainless steel end caps and stems; said to afford full ½ in. pipe flow area—*Valvair Corp.*, 454 *Morgan Ave., Akron* 11, *O.*

Cleaning Additive . . .

. . . for use in tanks and closed systems in conjunction with standard solutions; neutral in pH, contains no phenols, may be used in tanks at temperatures from 140 to 160 F and in closed systems between 180 and 200 F—*Oakite Products Inc.*, 19 *Rector St., New York, N. Y.*



Fan Wheels . . .

. . . feature improved blade design and streamlined backplate, tested static efficiencies from 79 to 85 percent, according to manufacturer—*Dryer Electric Corp., Fan Div.*, 164-166 *Wallabout St., Brooklyn* 6, *N. Y.*

Some Straight Talk On Steam Trap Capacity

... or pulling away the curtain of confusion that surrounds steam trap capacity ratings.

Unfortunately, for the steam trap buyer, the subject of steam trap capacity has become cloudy and confused by a landslide of claims, counter-claims and inconsistent "standards" for measurement. So let's take a cold hard look at this subject so vital to the efficient operation of your plant.

What Determines Steam Trap Capacity?

There are three factors that determine the capacity of a steam trap:

1. The area of the orifice.
2. The density of the condensate.
3. The pressure differential across the trap.

Let's take a closer look at each of these:

Area of orifice is usually specified by the trap manufacturer or can be calculated from the diameter. Nothing complicated here.

Density of condensate depends on temperature. A cubic foot of cold water weighs 62.4 lbs. At 250° F. or 15 psi, it weighs less than 59 lbs. This is important. Don't overlook it.

Pressure differential across the trap is most significant. And it is complicated by the many factors that affect it, such as:

1. Pressure drop between unit drained and the trap when the trap valve is open.

2. Distance the trap valve is moved from the valve seat.

3. Back pressure on the trap with orifice closed; i.e., return header pressure.

4. Increase in back pressure produced by condensate and flash steam flowing in the discharge line. This in turn is affected by the diameter and length of the discharge line, plus friction caused by valves and fittings.

Orifice Capacity Vs. Steam Trap Capacity

Figure 1 shows a ½" diameter sharp-edged orifice at the end of a pipe filled with cold water at 15 lbs. pressure. The capacity of this orifice, using a .61 coefficient of flow would be 8,800 lbs. per hr. Now, would this ½" orifice if used in a ¾" steam trap installed as shown in Figure 2 provide the trap with a continuous discharge capacity of 8,800 lbs. of hot condensate per hour? The answer is "no". And here are some of the reasons why:

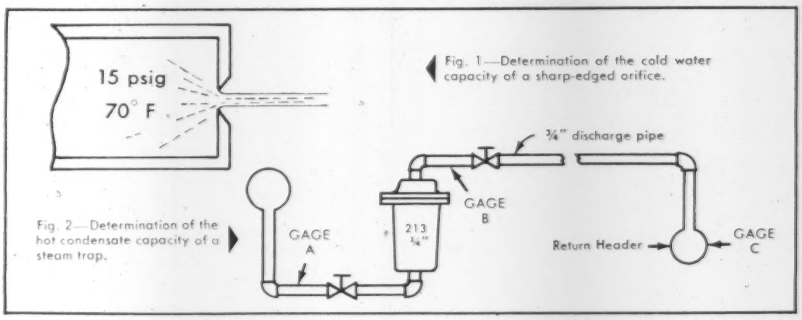


Fig. 1—Determination of the cold water capacity of a sharp-edged orifice.

Fig. 2—Determination of the hot condensate capacity of a steam trap.

Density of condensate. As pointed out above, cold water weighs 62.4 lbs. per cu. ft. At 15 lbs. pressure and 250° F. water weighs less than 59 lbs. per cu. ft. This difference in density alone reduces the lbs. per hour capacity of the orifice by over 5%.

Pressure differential across the trap. With the trap valve closed we have a static pressure differential of 15 psi. The trap valve must be able to open against this pressure. However, this is not the pressure differential that will determine the capacity of the trap valve.

The ¾" discharge line will be full of a mixture of flash steam and condensate. To keep this mixture flowing from the trap outlet to the return line requires a pressure differential. In actual capacity tests run as shown in Figure 2 Gage B at the trap outlet registered 11 lbs. back pressure. Thus the true pressure differential across the trap was about 4 lbs. Under these conditions the measured capacity of the trap was 4,340 lbs/hr. or just about half of the capacity of the ½" orifice for cold water.

How Armstrong Determines Capacity Ratings

Armstrong trap capacity ratings are based on hundreds of tests under actual operating conditions. In these tests, the condensate used was at the steam temperature corresponding to the test pressure. Thus, the capacities determined take into account the pressure drop that occurs when the trap orifice opens and the choking effect and back pressure of the flash steam. Actual installation hook-ups were used so that pipe friction in both inlet and discharge lines as well was reflected in the results.

Let's go back to the example cited above and in Figure 2. The trap referred to is an Armstrong No. 213. While it did test out at 4,340 lbs. per hour for a static pressure differential of 15 psi, it is rated in the catalog at only 3900 lbs. per hour for this pressure—just to be on the safe side.

For the trap buyer, this means that Armstrong Steam Trap capacities are based on handling condensate at steam temperature for the stated static steam pressure differential under actual working conditions.

Capacity ratings which don't take into account all of the variables will be misleading and may lead to the selection of undersized traps. So whenever you specify or buy traps be sure that the capacity ratings you work from are realistic. One way to be sure is to select Armstrong Traps with *guaranteed* capacity ratings.

* * *

Additional information on trap capacity ratings, plus data on how to correctly size, install and maintain steam traps for any pressure, any temperature and any load, are presented in the 48-page Armstrong Steam Trap Book. Ask your local Armstrong Representative for a copy or write:

Armstrong Machine Works
8744 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

67 Problems Solved by Van-Cor PVC Pipe & Fabrications

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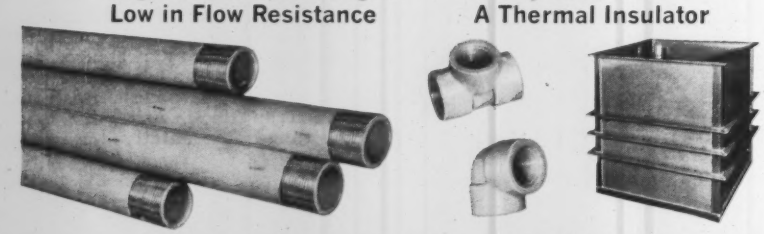
Piping Hydrochloric Acid
Piping Nitric Acid
Piping Battery Acid
Piping Vinegar
Piping Brine
Piping Natural Gas
Piping Ammonium Nitrate
Piping Gasoline
Piping Fluoridation materials water system
Piping Sodium Hypochloride (Bleach)
Piping Pulp Stock Lines
Piping Uranium ore slurry
Piping Sand slurry
Piping Coal slurry
Piping Waste Lab Drains
Piping Cyanide
Piping Plating Solutions
Piping Mercury (tube filling)
Piping Pickles
Piping Polysulfide
Piping Wine
Piping Gin
Piping Whiskey
Piping Sea water
Piping Chicken feed
Piping Demineralized H_2O
Piping Warm glue
Piping Salt water
Piping Crude oil
Piping Drinking water
Piping Irrigation water
Piping Chilled water
Piping Sewage
Electrical Conduit
Fishing Boat Outriggers
Stair Handrails
Vent Stacks
Stand Pipes
Downspouts
Cathodic Protectors
Electrolytic Interruptors
Pneumatic Conveying

FABRICATIONS

Plating fumes
Hydrofluoric Fumes (Scrubber and duct)
Meat Cutting Boards
Spray Booths
Roll Coverings
Swimming Pool H_2O Treatment
Chicken Feed Troughs
Gutters
Plating Racks
Electrolyte Diffusers
Agitator
Noise Dampeners
Sinks
Laboratory Table Tops
Photographic Trays
Etching Trays
Pump Bodies
Etching Machinery
Tumbling Barrel Liners
Plating Drums
Loading Chute Liners
Laboratory Fume Duct
Laboratory Fume Hood
Tanks & Tank Liners

VAN-COR SOLVED THESE PROBLEMS BECAUSE IT IS:

Chemical Resistant
Light Weight
High in Tensile Strength
Low in Flow Resistance
Impact Resistant
Dielectric
Easily Installed
A Thermal Insulator



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Subsidiary of THE VAN DORN IRON WORKS CO.

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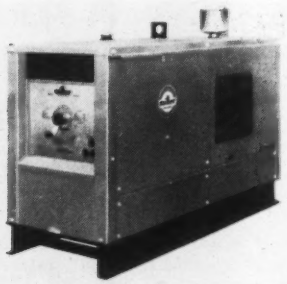
EQUIPMENT DEVELOPMENTS

Continued

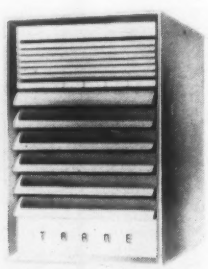


Arc Welder . . .

. . . combined with a-c power plant, diesel drive delivers 50 to 200 amp and 150 to 350 amp d-c welding ranges, 12 kw, 115 to 230 v, 60 cycle a-c power and 6.5 kw a-c plus 1 kw, 115 v auxiliary d-c while welding—*Miller Electric Mfg. Co. Inc., Appleton, Wis.*

Portable Air Cooler . . .

. . . with activated charcoal filter to purify air it cools; filter removes odor, smog particles, pollens from air as it cools; purifier works only when actually absorbing contaminants from air; units can be used year around for cooling or for air circulation and ventilation.—*Write Mfg. Co., 2902 W. Thomas Rd., Phoenix, Ariz.*



Space Heaters . . .

. . . gas fired, available as 30,000 to 250,000 Btu per hr propeller and blower heating units and 60,000 to 250,000 Btu per hr duct heaters; feature welded aluminized steel heat exchangers, light-weight burners—*The Trane Co., La Crosse, Wis.*

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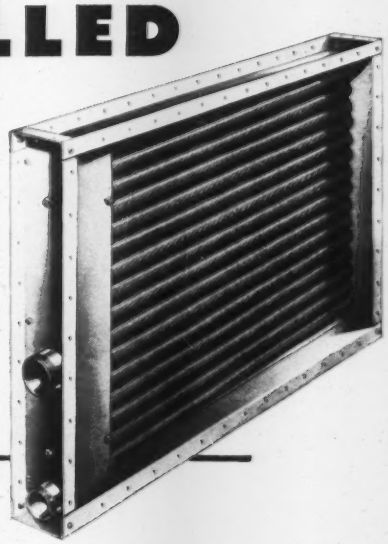
Plumbing-Heating-Air Conditioning

AEROFIN INSTALLED



Modern smooth-fin design of Aerofin coils permits ample heat-exchange capacity in limited space — permits the use of high air velocities without turbulence or excessive resistance.

Aerofin performance data are laboratory and field proved. You can safely specify Aerofin coils at full published ratings.

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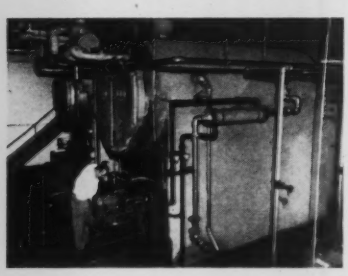
"Performance made choice easy,"

Says University Towers President

"There was never any doubt as to the make of oil burners we'd install in University Towers, our three new 15-story apartment buildings in Brooklyn," says Benjamin Neisloss, president. "Experience during the 25 years we've used them exclusively in our other apartment buildings proved Enterprises to be top performers – unusually economical, trouble-free and efficient."

This choice of additional Enterprise burners by a long-time user is typical of scores of such installations we make each year. Whatever your heavy duty commercial or industrial application, look to Enterprise for the finest in a complete range of oil and combination oil and gas burners from 4 to 200 gph. Complete information and illustrated specification sheets available on request.



Abundant, dependable, economical heat for the 549 family units in the huge University Apartments, Brooklyn, N.Y., is supplied by 6 Pacific Loset boilers fired by 6 Enterprise J3-P fully automatic oil burners. Installation was made by Enterprise Engineering Co. Inc., Brooklyn, N.Y.

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▸ *AIR COOLED CONDENSER*—requiring no motors, fans, water, is featured in new manual which includes detailed explanation of operating principle, operating advantages, installation instructions, trade prices. *Edwards Engineering Corp., Dept. HPAC, 101 Alexander Ave., Pompton Plains, N.J.*

▸ *ALUMINUM ALLOYS*—for industrial applications in booklet which contains description and guides to various finishes, charts listing alloys available and mechanical properties of each; also outline of general specification and recommended protective measures. *Metals Div., Olin Mathieson Chemical Corp., 400 Park Ave., New York 22, N.Y.*

▸ *ATMOSPHERIC CORROSION*—problems treated in three separate research papers: 1) Theory of the Mechanism of Rusting of Low Alloy Steels in the Atmosphere, 2) Extra Durability of Paint on Low Alloy Steels, 3) Design and Interpretation of Atmospheric Corrosion Tests. *Inco Corrosion Reporter, The International Nickel Co. Inc., 67 Wall St., New York 5, N.Y.*

▸ *BALL VALVES*—brochure entitled "At Your Service" is digest of line of valves, including list of data sheets available on any particular valve in the line. *Jamesbury Corp., Worcester, Mass.*

▸ *CIRCUIT BREAKERS*—bulletin "GEA-7070" provides selection, application, drawings and ordering information for line of symmetrical terminal, molded case units. *General Electric Co., Distribution Unit, 90 Whiting Street, Plainville, Conn.*

▸ *CIRCULATING PUMPS*—for use in high temperature hot water heating systems discussed in "Technical

FOR EASY INSTALLATION, ECONOMY & TOP PERFORMANCE

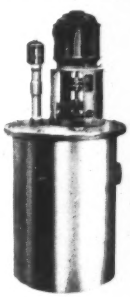
Specify AURORA®

PUMPS and CONDENSATE RETURN UNITS

Low NPSH—Smooth, quiet operation • high efficiency • less initial cost and lower operating expense • compactness

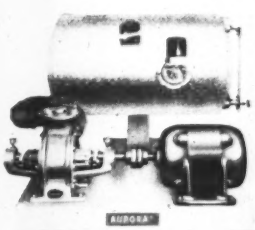
For many years Aurora Centrifugal Pumps and APCO Turbine Type Pumps, and Aurora Condensate Return Units have been serving a broad variety of heating and air conditioning applications with maximum dependability and operating efficiency. Applications include: condenser circulation, boiler feed, cooling towers, air conditioning systems, hot water circulation, and many special operations.

These Aurora Pumps and units are available in many different types and capacities for every type and size of operation. They are quality built for long, trouble-free operation. When maintenance is necessary, repairs can be made quickly and easily to get the pumps and system back in operation fast.



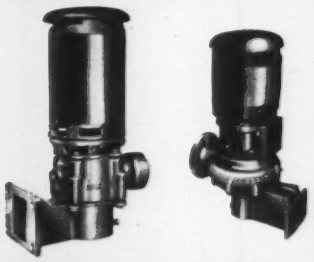
Vertical Unit

For high capacities with special conditions . . . packing box only . . . ideal for applications where return is extremely low or below floor level . . . available as either simplex or duplex units. Capacities to 100,000 EDR—pressures to 60 PSI.



APCO
Horizontal Unit

Steel or cast iron receivers . . . turbine type pumps with vertical centerline discharge will not vapor lock . . . high efficiency . . . packing box standard . . . mechanical seals optional . . . available as either simplex or duplex units. Capacities to 100,000 EDR to 115 PSI.



Type BJF and BCF
Flange Mounted

Especially applicable for OEM Equipment . . . Vertical mounting close-coupled design for maximum compactness . . . minimized space requirements . . . simplified, low suction mounting . . . optional discharge arrangements . . . low NPSH. Capacities to 1800 GPM and heads to 320 feet.

Type BP
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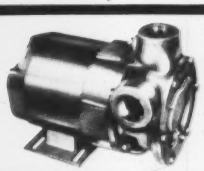
22 packaged sizes . . . stainless steel seals for maximum corrosion resistance . . . stainless steel motor shaft . . . cast bronze impeller . . . self-venting with vertical discharge . . . low NPSH. Capacities to 450 GPM and heads to 140 feet.

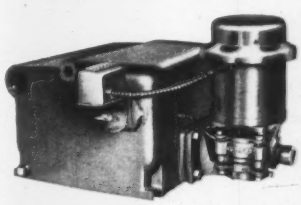


Model V-4
Close-Coupled Pumps

Maximum simplicity . . . single stage . . . mechanical seals . . . optional self-priming feature. Capacities to 30 GPM . . . Heads to 350 feet.

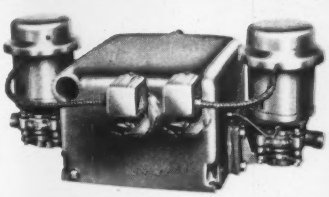
Type BCH
Close-Coupled End-Suction

With self-venting vertical discharge . . . interchangeable mechanical seal or packing inserts . . . low NPSH . . . unique suction spool arrangement. Capacities to 1800 GPM and heads to 320 feet—also available with flexible coupled drive.



Type CP
Cond-A-Pac Unit

Utmost compactness . . . cast iron receiver . . . mechanical seals . . . close-coupled . . . low return . . . complete unit ready for installation of lead lines. Capacities to 15,000 EDR—20 PSI. Also available as Type AR with APCO Turbine Type pumps—capacities to 10,000 EDR—pressures to 80 PSI.



Type C
Heavy Duty Unit

For high capacity or heavy duty applications . . . broad flexibility . . . cast iron receiver . . . low return . . . mechanical seals standard . . . packing boxes on pumps optional when desired. Capacities to 150,000 EDR—pressures to 125 PSI.

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AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY

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LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK

which size stack do YOU prefer?

Each does the same job— the smaller one is equipped with a Lehigh Induced Draft Fan

Lehigh Induced Draft Fans are designed to help eliminate large, costly, unsightly stacks. They maintain a *constant* over-fire draft regardless of atmospheric conditions, help keep boilers operating at *maximum* efficiently at all times, and significantly *lower fuel bills* . . . while radically *reducing* the size of your stack.

Rugged Construction—long life: to prevent distortion under elevated temperature conditions, the fan housing, bearing pedestal, motor support and fan wheel of Lehigh Draft Induced Fans are constructed of all-welded integral $^{3}/_{8}$" mild steel. A radiant heat cover and an aluminum heat flinger protect the inboard bearing from radiated heat. And because both bearing and shaft are kept to a low operating temperature, the Lehigh Induced Draft Fan makes use of standard, self-aligning ball bearing pillow blocks. *All* Lehigh Induced Draft Fans feature a flanged inlet, flanged outlet, and inspection cover as standard equipment.

If you would like to reduce stack height . . . and gain optimum boiler efficiency . . . contact your local Lehigh Representative today. He'll gladly give you all the details. Or write directly to us for our detailed technical bulletin:

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LF-1

LEHIGH FAN & BLOWER DIVISION
FULLER COMPANY, CATASAUQUA 3, PA.
Subsidiary of General American Transportation Corporation

TRADE LEHIGH MARK

RECENT TRADE LITERATURE

Continued

Bulletin #5". *Chempump Div., Fostoria Corp., P.O. Box 35-24, Huntingdon Valley, Pa.*

▸ *CONCRETE DRILLING*—manual contains instruction procedures for cutting openings of 1 in. or less in slab. *Flexicore Co., Inc.,* 1932 *E. Monument Ave., Dayton, O.*

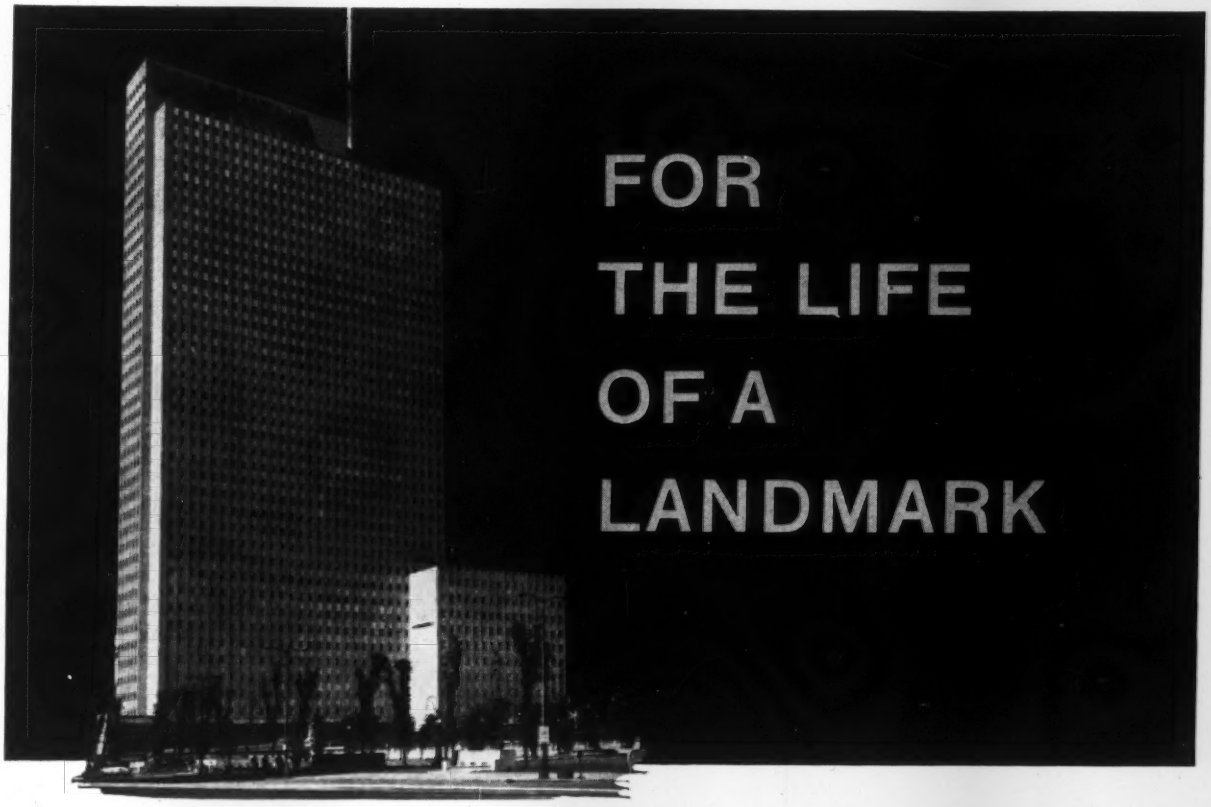
▸ *CORROSION CHART*—lists 150 chemicals and recommended usage with ductile iron, iron, steel, stainless steel, monel, brass, bronze, copper, aluminum and plastisol plastic; Chart "J-CRC". *OPW-Jordan,* 6013 *Wiehe Rd., Cincinnati* 13, *O.*

▸ *CORROSION DATA SHEET*—explains causes and action of boiler, cooling and process water system corrosion; titled "How Corrosion Attacks Industrial Water Systems." *Betz Laboratories Inc., Gillingham & Worth Sts., Philadelphia* 24, *Pa.*

▸ *CORROSIVE GAS SEPARATOR*—described in catalog "S-6900;" includes discussion of collection efficiency and pressure drop of impervious graphite entrainment separator modules, with table of dimensions and weights. *National Carbon Co.,* 535 *Fifth Ave., New York* 17, *N.Y.*

▸ *DUCT INSULATION*—for air conditioning systems, discussed in sound, strip film titled "Building Weather;" covers development of normal inside design conditions; available to groups, approximately 16 min long. *Armstrong Cork Co., Dept. BW, Lancaster, Pa.*

▸ *DUCT SILENCERS*—for high pressure air conditioning and ventilating systems described in new literature. *Industrial Acoustics Co. Inc., Air Conditioning Dept.,* 341 *Jackson Ave., New York* 54, *N.Y.*

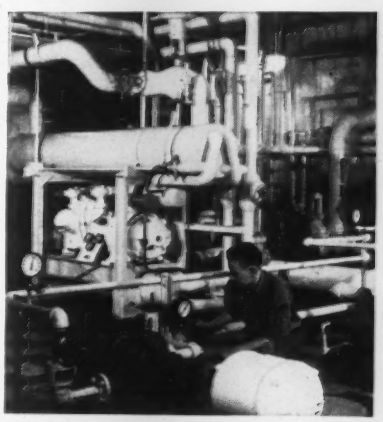


Long-term dependability... 19.3 miles of Republic Steel Pipe installed in Chicago's Prudential Building

Over 100 thousand feet of Republic Steel Pipe was installed in this 41-story Chicago landmark. *Steel*—because low-cost steel pipe is good for the life of any building. *Republic*—because M. J. Corboy Corporation, plumbing contractors, demands steel pipe with the highest possible degree of workability.

Constant quality control *guarantees* that workability. You enjoy easier bending, cutting, welding, and threading. What's more, you can rely on the strength of steel for long, unsupported runs; on the availablity of steel for minimum variation in price or delivery; on the tight, galvanized coating of Republic Steel Pipe for stubborn resistance to corrosion and fabrication damage.

See for yourself! Your Republic distributor will give you a complete run-down on the immediate and long-term savings offered by Republic Steel Pipe. Call him today or write to Republic Steel Corporation, Dept. HP-7663-A, 1441 Republic Building, Cleveland 1, Ohio.

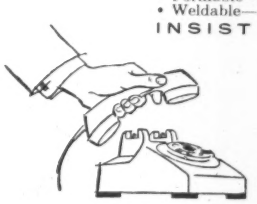


PRUDENTIAL BUILDING PLUMBING SPECIFICATIONS called for 77,710 feet of ½″ through 12″ galvanized steel pipe, plus 24,600 feet of 1″ through 12″ black steel pipe. Installation was handled by the M. J. Corboy Corporation, Chicago. Building architects were Naess & Murphy, also of Chicago.

STEEL PIPE IS FIRST CHOICE

- Low cost with durability
- Strength unexcelled for safety
- Formable—bends readily
- Weldable—easily, strongly
- Threads smoothly, cleanly
- Sound joints, welded or coupled
- Grades, finishes for all purposes
- Available everywhere from stock

INSIST ON PIPE MADE IN U.S.A.



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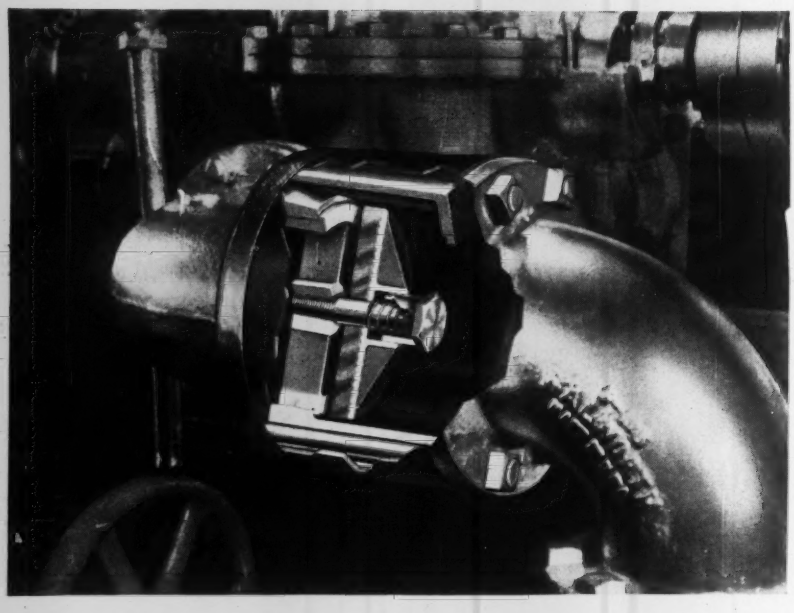
REPUBLIC *Steel Pipe*



CPV CHECK VALVES ARE SILENT

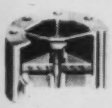
. . . and this non-slam feature is your *positive* assurance of a silent, safer piping system, with protection to the pump, and other equipment.

Easily installed wherever liquid flows, a CPV Check Valve closes automatically as soon as forward flow stops. The valve is closed before any reverse flow occurs. Dangerous line surges and hammer are eliminated without expensive air cushions, shock absorbers and other devices.

Only CPV CHECK VALVES Give You All These Features

- Straight guided disc with two point bearing assures positive valve seating.
- Helical spring is engineered to close automatically as soon as forward flow stops.
- Ideal for all pressures and temperatures—including high temperature water.
- Available in a wide variety of materials, including Alconite, bronze, steel, stainless steel and monel.
- Easily installed in any position.
- Full radial flow with minimum head loss.
- Approved by Factory Mutual Laboratories for fire lines.
- Choice of four basic types in sizes from ½-in. to 18-in. or more.

Get the full story about CPV Silent, Non-Slam CHECK VALVES. Write today for Catalog C.


STYLE G . . . 2-10"

STYLE GB . . . 6-18"+

STYLE NU . . . ½-2"

STYLE H . . . ½-2"

COMBINATION PUMP VALVE CO.
851 PRESTON STREET • PHILADELPHIA 4, PA.
SOLD BY RELIABLE AGENTS IN PRINCIPAL CITIES

RECENT TRADE LITERATURE
Continued

▸ *ELECTRODES*—of more than 130 types and welding characteristics, current, suggested welding procedures specifications are covered in new data sheets. *National Cylinder Gas Div., Chemetron Corp., Dept. HPAC, 840 N. Michigan Ave., Chicago* 11.

▸ *EXPANSION TANK*—pressurized diaphragm type for hydronic systems, described in folder which includes illustration of manufacture and diagram of operation, plus sizing chart. *American Tube Products, Inc., West Warwick, R.I.*

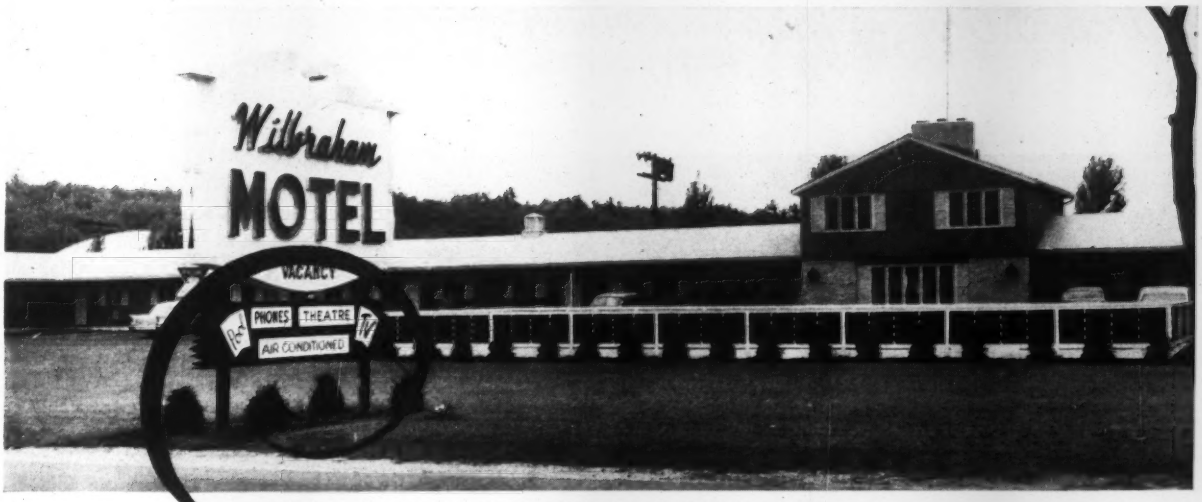
▸ *FASTENERS*—for various metal-working operations described in catalog illustrating available pins and stumps, blind bolts, and blind rivets. *Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich.*

▸ *FLEXIBLE CONNECTORS*—for pump installations, hot water and steam systems, described in new catalog. *Pennsylvania Flexible Metallic Tubing Co., 7200 Powers Lane, Philadelphia, Pa.*

▸ *FLEXIBLE COUPLINGS*—for power transmission described in new catalog "60;" includes explanation of misalignment, load classification, illustrations of available coupling types and installations. *Thomas Flexible Coupling Co., Warren, Pa.*

▸ *GAS BURNERS*—specification sheet gives size and operation characteristics including photographs of flame patterns for each type, and dimensional drawings. *Barber Mfg. Co., 1052 E. 134 St., Cleveland 10, O.*

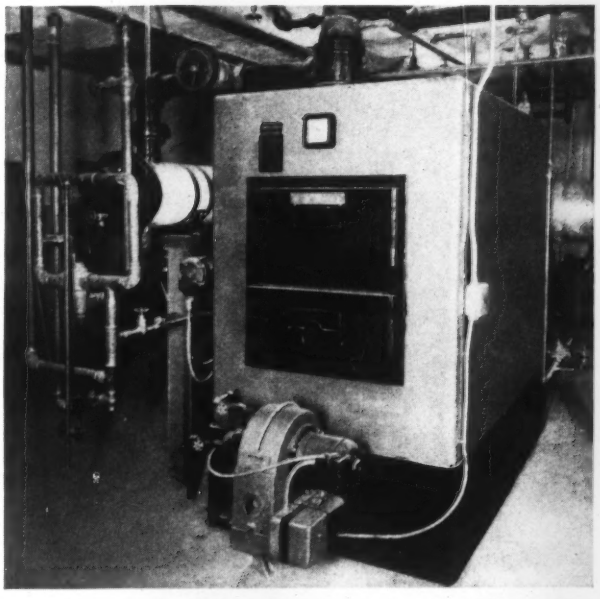
▸ *GAS REGULATORS*—without gages designed for use with oxygen, acetylene, or propane are described in new data sheet which includes design features and specifications. *Linde Co., Dept. HPAC, 30 E. 42nd St., New York* 17.



Wilbraham Motel, U.S. 20 and Boston Road, Wilbraham, Mass.

EVERYTHING FOR LUXURY TRAVEL...
INCLUDING DEPENDABLE HEATING WITH A

WEIL-McLAIN No. 82 BOILER-BURNER UNIT



No. 82 Capacities: Hot Water, 339,100—793,700 BTU/hr.
Steam, 1415—3305 sq. ft.

Send for bulletin C-270. For other Weil-McLain Gas and Oil Boilers see Engineers' Product File or Sweet's Architectural File.

OWNER: Mr. Clarence Potvin **MANAGER:** Mr. Roland E. Duris
DESIGNER: Mr. Philmore H. Colburn, Springfield, Mass.
ENGINEERS AND HEATING CONTRACTORS:
Caron Heating Company, Ludlow, Mass.

This ultra-modern, 24-unit motel includes lounge, kitchens and owner's apartment. It offers outstanding convenience and entertainment features...plus the genuine comfort of a hot water heating system supplied by a Weil-McLain No. 82 boiler-burner unit.

In this rugged, cast iron boiler, exclusive Weil-McLain designs assure the efficient combustion of fuel and absorption of heat. No. 82 Boilers are available as "B" units, furnished with burner, combustion chamber and controls —as "A" units, with combustion chamber and flange-mounted base front only—and as "O" units with rectangular opening in base front, no burner or combustion chamber. Easy assembly with short draw rods and asbestos rope seal reduces erecting costs.

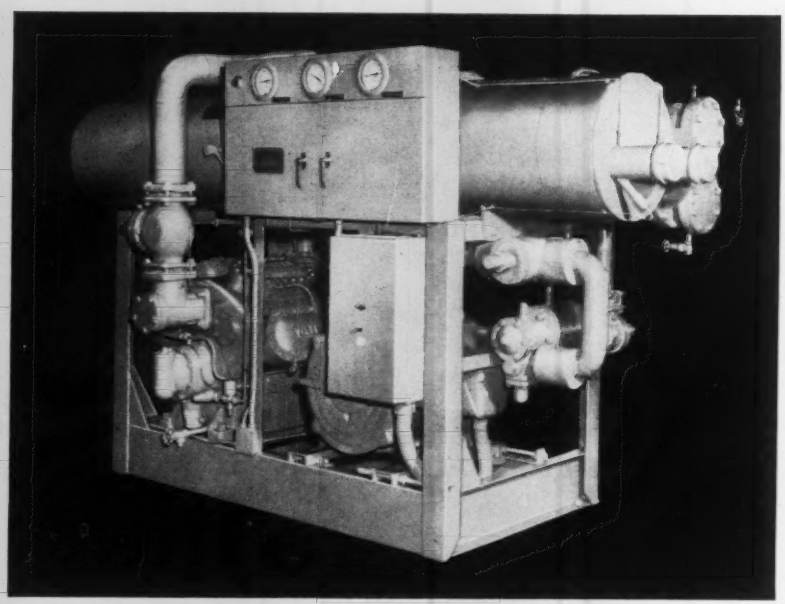
In the installation shown here, an indirect heater with pumped boiler water circulation is used to supply the unusually heavy hot water demands of the motel rooms and kitchens. For normal loads, a special feature of the No. 82 boiler permits installation of single or double domestic water heaters. Dual heaters offer a choice of three advantages: (1) increased volume of hot water, (2) hot water at two different temperatures, (3) one heater for snow melting.

WEIL-McLAIN
BOILERS · RADIATORS

WEIL-McLAIN COMPANY
MICHIGAN CITY, INDIANA

Address literature requests to Dept. AA-30

Air conditioning made easy with new space-saving fully flooded Vilter Chiller



View of the new Vilter Flooded Uni-Chiller—100-ton nominal capacity.

Compact, space-saving design, low cost and a flooded water chiller are some of the important advantages of the new Vilter flooded type Uni-Chiller.

While especially suited for air conditioning applications, Uni-Chillers fit readily into almost any liquid chilling system.

Four standard sizes are offered—25, 50, 75 and 100-ton nominal capacities.

All components are sized to operate efficiently as a system. The flooded-type shell and tube cooler and the condenser are mounted above a rugged Vilter VMC compressor. Shipped assembled, the Uni-Chiller arrives with all interconnecting piping completed, controls factory wired, cooler and low-temperature piping insulated and a holding charge of refrigerant.

Motor and starter can also be supplied by Vilter and if desired, the compressor and motor can be run-in and all controls and gauges properly adjusted and set. By specifying a completely assembled unit, installation costs and start-up time are reduced . . . real savings to you.

Why not contact your nearest Vilter representative or write directly to Vilter for full details and application recommendations.

Vilter® refrigeration air conditioning

The Vilter Manufacturing Company
Milwaukee 7, Wisconsin

Air Units • Ammonia and Freon Compressors • Booster Compressors Baudelot Coolers • Water and Brine Coolers • Blast Freezers Evaporative and Shell and Tube Condensers • Pipe Coils Valves and Fittings • Pakice and Polarflake Ice machines.

We will be pleased to send you complete details on the above equipment.

Write Vilter Dept. F-913

RECENT TRADE LITERATURE
Continued

▸ *GAS VENT PIPE*—for venting gas-fired heating equipment and water heaters is described in new catalog No. "1" which includes installation instructions. *Hart & Cooley Mfg. Co., Dept. HPAC, Holland, Mich.*

▸ *GATE VALVES*—in sizes from ½ in. to 12 in. with high visibility bonnet joints and extra long bolts for storage of bolting energy as described in eight page brochure "1010". *Ohio Injector Co., Dept. HPAC, Wadsworth, O.*

▸ *HAND TORCHES*—for gas welding and cutting; catalog gives general descriptions, features, specifications and photographs for line of torches and accessories. *Air Reduction Co., 150 E. 42nd St., New York 17, N.Y.*

▸ *HEAT EXCHANGERS*—bulletin "102.2" describes liquid heat transfer units and gives illustrated examples of applications. *Hynes Electric Heating Co., P.O. Box 1004, Mountainside, N.J.*

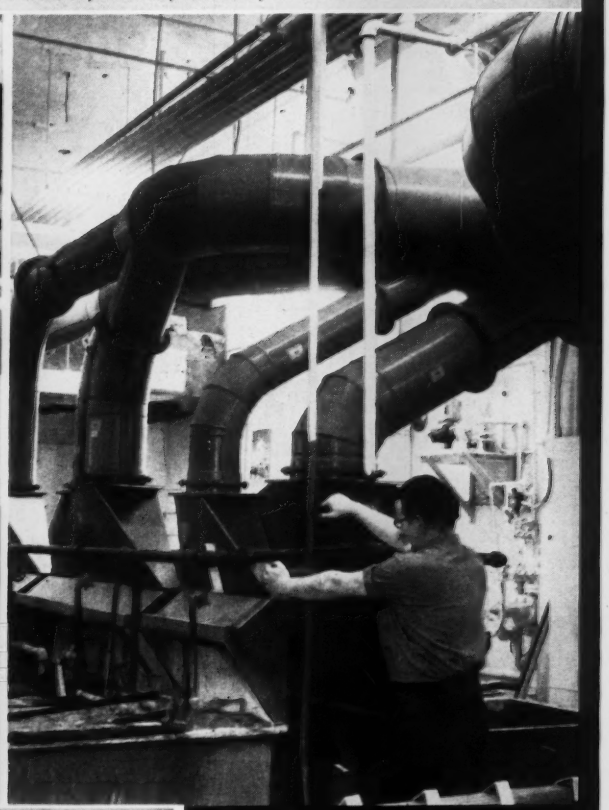
▸ *HIGH PRESSURE AIR CONDITIONING*—brochure "HCD 341.04" contains reproduction of hot and cold duct unit, dimensional drawings, and nominal rating tables; sent with fan performance curve charts. *Drayer-Hanson Div., National-U.S. Radiator Corp., 3301 Medford St., Los Angeles 63, Calif.*

▸ *HOSPITAL PIPING*—booklet gives steps in silver brazing copper tubing and medical gas system information. *National Cylinder Gas Div., Chemetron Corp., 840 N. Michigan Ave., Chicago 11, Ill.*

▸ *INFRARED HEATERS*—catalog "PC 1-59" gives specifications and dimensions on gas fired units, describes construction features and lists control arrangements. *Panelbloc Div., Bettcher Mfg. Corp., 3106 W. 61 St., Cleveland, O.*

Industrial Plastic Fabricators, Inc. reports . . .

Complete Boltaron 6200 installation . . . ducts, tanks, hoods, blowers



Boltaron® 6200

handles chemical & industrial fumes safely and economically

Boltaron 6200 IS BEST BECAUSE:

- Protects against most corrosive fumes and liquids in any combination.
- Resists build-up of residual materials from corrosive fumes and liquids.
- Solid Boltaron has no coatings to peel or chip —does not require recoating or repainting.
- Chemically inert.
- Non-toxic, imparts no taste or odor.
- Can be welded, bolted, threaded, milled, ground, buffed and polished.
- Non-sparking—will not support combustion —handles fumes and liquids.
- High dielectric strength.
- Extremely lightweight—non-porous—and smooth surface.
- Tensile strength is 8000 psi.
- Can be joined by heat welding, solvent cementing, and threading.

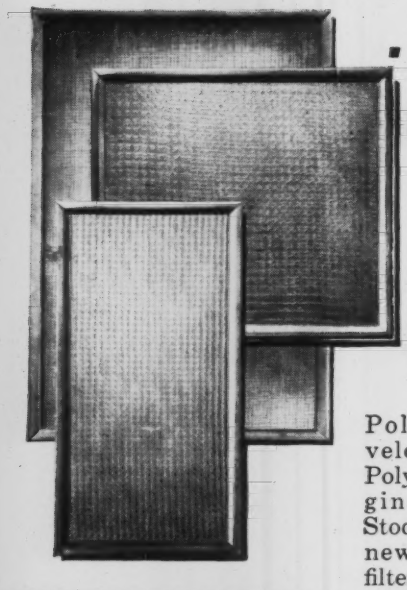
IPF systems fabricated from Boltaron 6200 are being used the nation over by many progressive manufacturers to solve numerous industrial problems, especially where corrosive fumes and liquids have been extremely costly to handle. Performance proves Boltaron 6200 systems help decrease operating costs—increase operating efficiency.

For further information on performance-proven Boltaron 6200 systems, call or write:
Industrial Plastic Fabricators, Inc., Endicott Street, Norwood, Mass.

THE GENERAL TIRE & RUBBER COMPANY • Bolta Products Division • Lawrence, Mass.

NOW Poly-Mag 80!

...and only in



DUST-magnet FILTERS

a product of

STODDARD INDUSTRIES

Poly-Mag 80 is a newly developed, highly electrostatic Polyester plastic exclusively engineered and produced for Stoddard Industries. With this new material, DUST-magnet filters are now more effective in every way . . . higher resistance to shrinkage . . . lower pressure drop . . . unaffected by humidity, or temperatures up to 230° F.

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They are guaranteed for the life of the unit in which used . . . cleaned in minutes with no messy oil coating needed.

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Customer satisfaction . . . standard sizes . . . excellent profit margin.

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Models are available for residential, commercial and industrial use . . . competitively priced . . . delivered promptly.

SERVICEMEN SATISFACTION
Reduce operating costs and improve efficiency of furnace and air conditioning systems . . . ease of installation.

Just rinse, shake and replace . . . that's it.

Trap dust particles as small as 4/10 micron.

Cleaner, fresher, purer air means less housework.

DUST-magnet FILTERS

a product of Stoddard Industries

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RECENT TRADE LITERATURE
Continued

▸ *LIQUID LEVEL CONTROL*—for flooded evaporators combines thermostatic element with artificial heater; detailed in bulletin "60-15;" for refrigerants 12 and 22 and ammonia. *Sporlan Valve Co.*, 7525 *Sussex Ave.*, *St. Louis* 17, *Mo.*

▸ *LIQUID SERVICE VALVE*—bulletin "L-100 59" gives details and specifications on sizes, capacities, and materials. *J. E. Lonergan Co.*, *Second and Race Sts.*, *Philadelphia* 6, *Pa.*

▸ *MECHANICAL JOINING OF ALUMINUM*—booklet covers various methods such as nails and pins, metal stitching, architectural fasteners and mechanically formed joints; available on letterhead request. *Reynolds Metals Co.*, *Dept. PRD-28*, *Richmond* 18, *Va.*

▸ *MERCURY SWITCH CONTROLS*—for single stage, two-stage, differential pressure, single and two-stage temperature, liquid level and mechanical movement, described and indexed in new catalog "860". *The Mercoid Corp.*, 1201 *Belmont Ave.*, *Chicago* 41, *Ill.*

▸ *NOISE CONTROL*—discussed in technical guide "Audio Spectrum Analysis" as basis for product evaluation instrument selection. *B & K Instruments, Inc.*, 3044 *W.* 106 *St.*, *Cleveland* 11, *O.*

▸ *PACKAGED BOILERS*—two catalogs give specifications, ratings, and dimensions for line of oil, gas, and combination fired steam or hot water units. *Cleaver-Brooks Co.*, 326 *E. Keefe Ave.*, *Milwaukee* 12, *Wis.*

▸ *PROTECTIVE COATING*—selector guide for wide variety of industrial applications, includes paint chips for color matching. *Master Bronze Powder Co.*, 538 *W. State St.*, *Calumet City*, *Ill.*

TOUGH BUYERS demand Reznor unit heaters...
In 70 years, only 1/10 of 1% factory replacement!

If you want to avoid extra servicing and call-backs, you've *got* to be a tough buyer! You've got to pick a heater that not only works right when you buy it, but will keep on working right. That's why so many plumbing, heating and air-conditioning contractors demand Reznor. There may be less expensive heaters on the market, but none with Reznor's long-term performance record: only 1/10 of 1% factory replacement in 70 years!

EVERY UNIT FLAME-TESTED... You can be sure that your Reznor heaters will arrive in top running order. We flame-test each unit before shipment. Saves you the bother and expense of uncrating and bench-testing, too.

LONG-TERM FUEL SAVINGS... Here's where your customers benefit from your "tough buying." Reznor's sensitive, low-voltage thermostat and controls, and two-speed fan with automatic speed selector, keep heat even, without blasts. A Reznor uses less fuel to maintain comfortable heat.

For the full story, phone your Reznor distributor, or write Dept. 51A, Reznor Manufacturing Company, Mercer, Pennsylvania.

The heating world is full of tough buyers; that's why Reznor is the world's largest selling direct-fired heater!

REZNOR HEATERS

"THE TOUGH BUYERS' LINE"

It costs money to cool sunshine!

Now...prove at your own desk how KOOLSHADE Sunscreen slashes air conditioning costs

Send today for this Free sample of Borg-Warner's KoolShade Sunscreen. Place it on a sunny desk or window sill. You'll see for *yourself* how KoolShade stretches your air conditioning dollar.

Saves on initial equipment. By screening out up to 87% of the sun's hot rays, KoolShade reduces your cooling requirements...cuts solar load about one ton for every 100 sq. ft. used. Result: you install a smaller unit, pay for the KoolShade out of the difference—and pocket a big savings besides!

Reduces operating costs. KoolShade keeps air conditioning units running more efficiently, more economically. Ideal, too, in bringing under-sized units up to par. And even without air conditioning, KoolShade keeps offices 15° cooler...cuts glare...boosts morale.

Send today for Free KoolShade Sample. Wherever you stand on air conditioning, it will pay you to investigate KoolShade.

Here's how KoolShade works

KoolShade Sunscreen works like a miniature venetian blind installed *outside* your windows. Tilted horizontal louvres (see cross-section, above right) intercept the sun's rays *before* they reach the window.

Place this "prove-it-yourself" sample on a sunny window sill. You'll see what KoolShade can do for you.

KOOLSHADE® SUNSCREEN

REFLECTAL CORPORATION
A subsidiary of Borg-Warner Corp.
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Chicago 4, Illinois.

0327

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☐ Free Sample

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Company .....
Address .....
City ..... Zone ..... State .....

RECENT TRADE LITERATURE

Continued

▸ *REGISTERS, GRILLES*—of extruded aluminum and air diffusers described and illustrated in catalogs which also give engineering data and sizing charts. *Air Distribution Products Co.*, 8201 *W. Third, Los Angeles* 48, *Calif.*

▸ *ROTAMETERS FOR CORROSIVE SERVICES*—bulletin "150" gives details of materials, and illustrates various types of meter design. *Brooks Rotameter Co., Hatfield, Pa.*

▸ *SHEET METAL SCREWS*—self tapping in metal up to 18 ga, described in bulletin "272-AC." *Air Control Products Inc., Coopersville, Mich.*

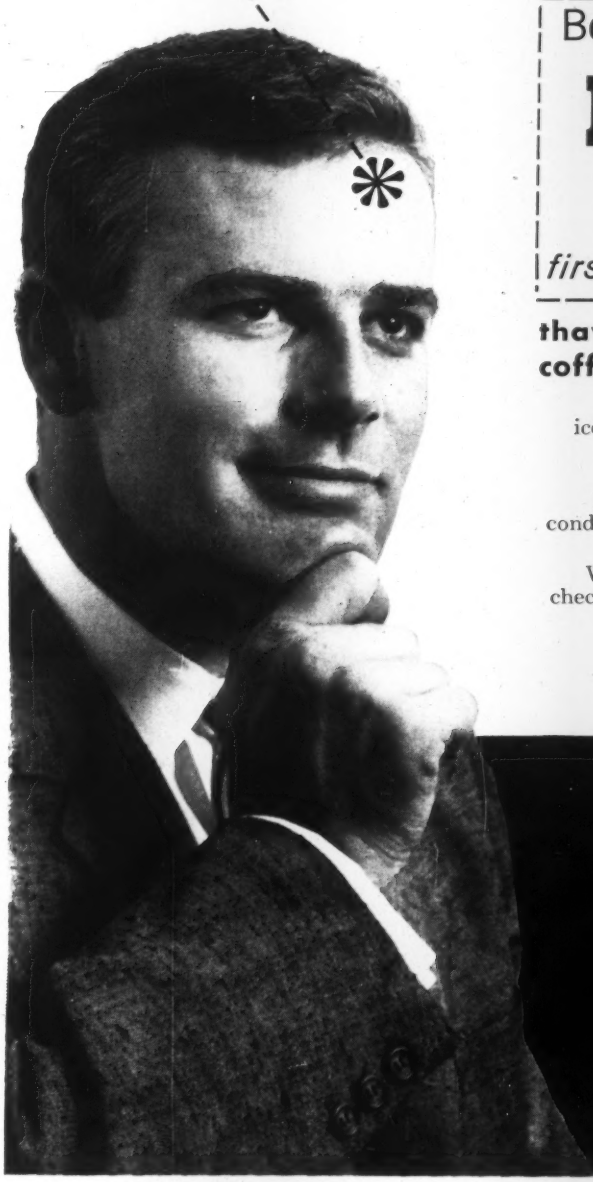
▸ *STEAM TRAP SIZER*—direct reading chart gives trap number, orifice size and piping connection description for high pressure cast iron, steel, and brass steam traps for pressures to 1000 psi and temperatures to 850 F. *The Clark Mfg. Co.*, 1830 *E.* 38 *St., Cleveland* 14, *O.*

▸ *SYSTEM CLEANER*—for use after flushing operation on air conditioning and refrigeration systems; consists of core-type drier with adaptors for attaching cleaner to compressor; described in bulletin "40-10-1." *Sporlan Valve Co.*, 7525 *Sussex Ave., St. Louis* 17, *Mo.*

▸ *TEMPERATURE CONTROL*—discussed in relation to product quality, cost saving, process research; gives basic concepts of electrical, pneumatic, and mechanical controls, with illustrative charts and diagrams and case histories; titled "Guide to Industrial Temperature Measurement and Control." *Partlow Corp.*, 532 *Campion Rd., New Hartford, N.Y.*

BE CONFIDENT

that your decision on space heating is Right!!



Before you select, check with...

NATIONAL Champion

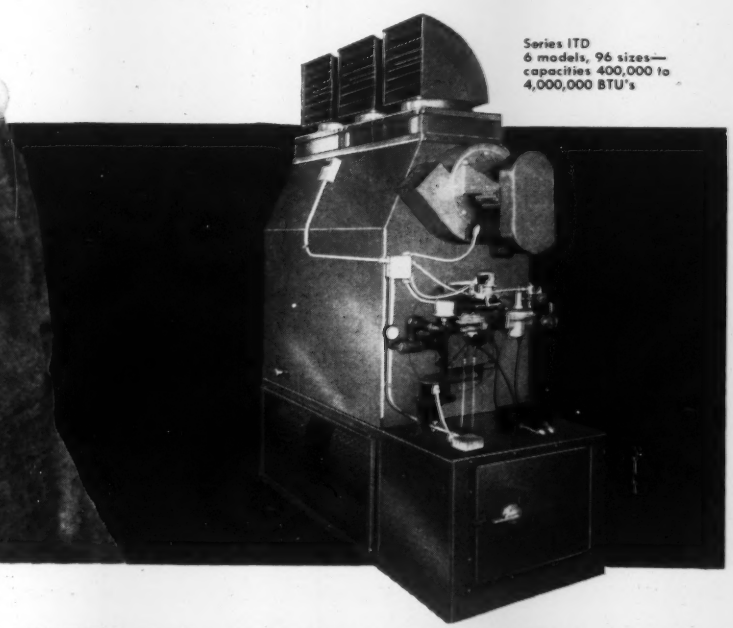
first in the space heating industry

thawing arctic ice or drying Venezuela coffee beans . . . National does it best!

Keeping the new US troposphere antenna system ice-free in the arctic circle at 80° below, to producing 285° temperatures for drying Venezuela coffee beans . . . National Champions handle the job.

For heating, ventilating, make-up air, drying or air conditioning . . . National offers you the largest selection of models and sizes in the space heating industry.

Whatever or wherever the job . . . before *you* select, check National!



Series ITD
6 models, 96 sizes—
capacities 400,000 to
4,000,000 BTU's

***Select with confidence!**

For information on the full line of
National Champion heaters call or write—

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Send Today for this New 60-page Catalog

Simplifies selection . . . speeds specifying!

Complete "buyer's guide" to Peerless Electric "Power Fixed" Blowers, covering sizes from 12¼" to 89" wheel diameters. Contains full performance tables, specifications, dimensions, selection and application data, and accessory information. All Peerless Electric Blower Assemblies carry the AMCA certified rating seal and are unconditionally guaranteed. Each complete unit is designed to exceed industry standards and is thoroughly tested before delivery. Fill in coupon for your copy of this helpful guide.

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H. K. PORTER COMPANY, INC., DEPT. 11-3,
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Gentlemen: Please send me your new catalog 260 on "Power Fixed" Blowers.

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COMPANY_____

ADDRESS_____

RECENT TRADE LITERATURE

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▶ *THERMAL INSULATION*—for —400 to 3000 F commercial and industrial requirements discussed in catalog "IN-244A;" includes information on various types of insulations, uses and specifications. *Johns-Manville Sales Corp., 22 E. 40 St., New York 16, N.Y.*

▶ *UNIT VENTILATOR*—gas fired for use in school classrooms, described in bulletin "685-A1;" gives construction features, engineering data, operation and controls information plus dimension drawings and weight charts, and application diagrams. *American Air Filter Co., Inc., Dept. PD, 215 Central Ave., Louisville 8, Ky.*

▶ *VACUUM FILTERS*—for industrial process water applications featured in bulletin "1860.20-2;" gives cut-away views, dimensional drawings and capacity charts for 240 and 720 gpm models. *B-I-F Industries Inc., 345 Harris Ave., Providence 1, R.I.*

▶ *VALVE MOTORS*—with yoke assembly in specification "S1016-2" which includes motor data and features, force ratings. *Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.*

▶ *VENTILATORS*—catalog provides guide to help match industrial equipment to specific needs; includes performance and dimension charts. *The Loren Cook Co., Berea, O.*

▶ *VERTICAL WATER HEATERS*—in five sizes from 220 to 565 gal storage capacity and with inputs from 250,000 to 500,000 Btu per hr are listed and described in bulletin "5214" which includes dimensions and other installation data. *Sellers Engineering Co., Dept. HPAC, 4776 N. Clark St., Chicago 40.*

The Burgess-Manning 3-Way Functional Ceiling

UNIFORM Radiant Heating
UNIFORM Radiant Cooling
UNIFORM Sound Absorption

has the

6 POINTS of SUPERIORITY

that make it your Best Buy

- **STRUCTURAL SIMPLICITY**
- **MAINTENANCE ECONOMY**
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- **THERMAL PERFORMANCE**
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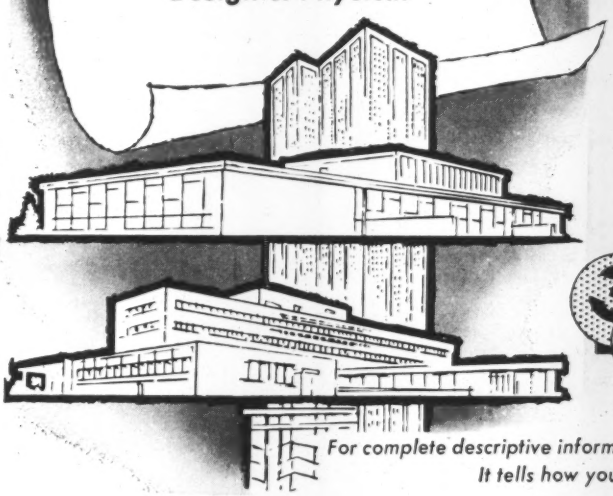

Additional Floor Space FREE — is yours when you choose a Burgess-Manning Ceiling.

3-Way in function . . . a triple value in day-in and day-out building performance.

Makes more floor space usable by locating the heating and cooling elements in otherwise waste overhead areas.

Cuts building operating costs . . . a cumulative year-in and year-out saving.

Produces superior comfort for occupants by supplying the *right kind* of wanted heat, and dissipating unwanted heat in the *right way* when cooling is necessary, while providing the most efficient acoustical control available.

Its Six Points of Superiority make it adaptable to any building plan and assures lasting satisfaction throughout the life of the building.

Over-all building budget no bigger for most installations.

3 Heating Cooling Acoustical

BURGESS-MANNING COMPANY
Architectural Products Division
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For complete descriptive information, write for "The Story of the Burgess-Manning Ceiling." It tells how you can obtain the ultimate in indoor comfort.

For *Residential* INSTALLATIONS

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NEW — Submersible SEWAGE PUMP
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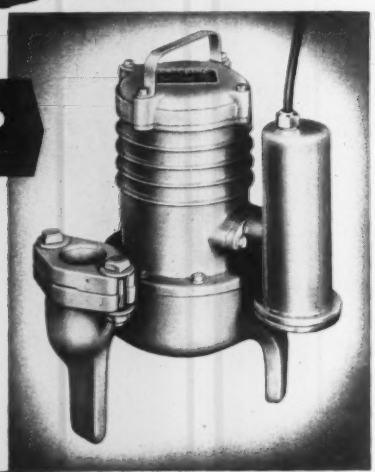
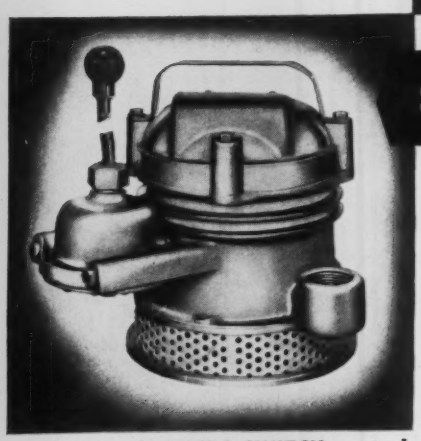
UL approved Submersible
SUMP PUMP
NOW IN JOBBERS' STOCKS



SEWAGE PUMP

2" Discharge
½ HP Capacitor Motor

This economical Sewage Pump permits installation of basement toilets and other fixtures where waste must be pumped up to sewer line.



SUMP PUMP

1¼" Discharge
⅓ HP Capacitor Motor

Quiet Operating submersible pumps delight the homeowner!

Automatic MICRO-SWITCH control. Provides the proper pumping cycle.

Factory assembled, ready to run, just plug in. (No expensive wiring)

Dependable hermetically sealed motors assure performance at all times. When current fails moisture cannot damage pump or motor.

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1514 NO. FREMONT ST., CHICAGO 22, ILL.

RECENT TRADE LITERATURE

Continued

▶ *WATER FILTERS*—with flat or concentric leaf filter elements described in bulletin "1860.20-2;" contains photographs, dimensional drawings, capacity charts and descriptive information. *B-I-F Industries Inc., 345 Harris Ave., Providence 1, R.I.*

▶ *WATER HEATER*—for commercial and industrial application described with diagrams illustrating operation as straight recovery heater, recovery booster heater and direct fired heater; includes specifications and capacities. *The Portmar Boiler Co., 193 Seventh St., Brooklyn 15, N. Y.*

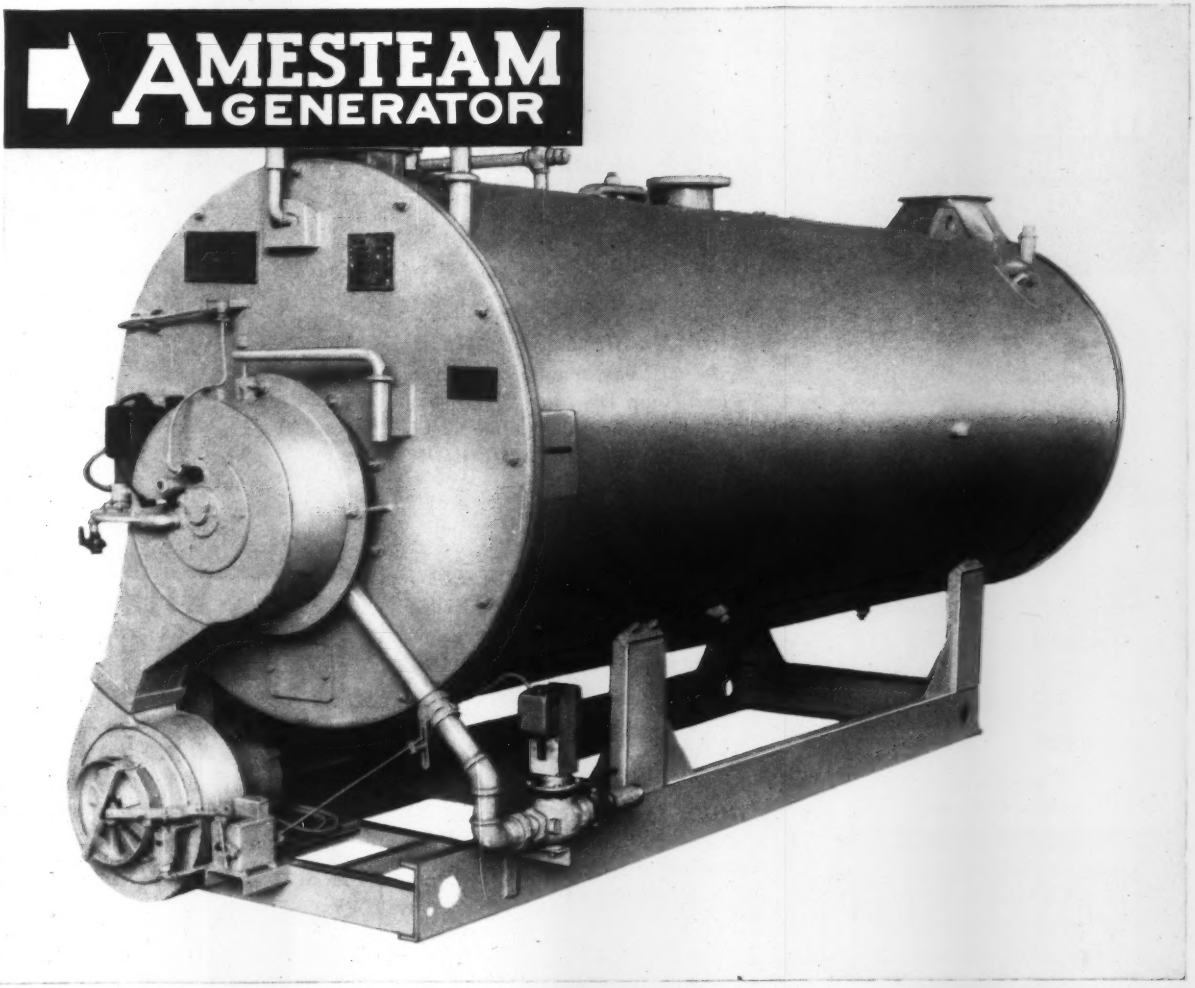
▶ *WATER TREATMENT PLANT CONTROL*—reprint "T-179" describes methods of control in demineralization plants, cold process softening, hot process and sodium zeolite systems; also review of recent developments. *Graver Water Conditioning Co., 216 W. 14 St., New York 11, N.Y.*

▶ *WELDING ACCESSORIES*—catalog "EW-211" gives information on extensive line of tools, clothing, miscellaneous equipment. *Hobart Brothers Co., Troy, O.*

▶ *WELDING ELECTRODES*—guide gives information on various types available, with applications, procedures and A.W.S.-A.S.T.M. data, plus charts for matching electrodes to trade name steels. *Air Reduction Sales Co., Inc., 150 E. 42nd St., New York 17, N.Y.*

▶ *WELDING FITTINGS*—are cataloged by size, dimensional, and physical data in bulletin "FDC-253", one of a series of 24 such data folders. *Babcock & Wilcox Co., Dept. HPAC, Tubular Products Div., Welding Fittings Dept. Milwaukee 46, Wis.*

AMESTEAM GENERATOR



PERFORMANCE that brings REPEAT ORDERS again and again

An AMESTEAM GENERATOR in operation is our best salesman for another. In fact, many of our customers have ordered 10 and more units on the strength of past performance. And this, in spite of lower bids.

Why? Because the AMESTEAM GENERATOR owner knows he has a good thing. He knows he has a quality boiler with all the proved features necessary to give him the economical steam he wants *when* he wants it. He's seen how little maintenance labor the unit requires, and how flexible it is to changing load demands. He's also enjoyed the assurance of expert AMES service, on call 24 hours a day.

Specify AMESTEAM GENERATOR for your power — processing or heat requirements. You won't be buying a cheap boiler. You *will* be buying years of cheap steam.

AMES IRON WORKS INC.
BOX D-30 OSWEGO, N. Y.

MAIL COUPON TODAY

AMES IRON WORKS
BOX D-30 OSWEGO, N. Y.

Gentlemen:
Please send me further information on AMESTEAM GENERATORS and name of the nearest representative.

NAME .....

COMPANY .....

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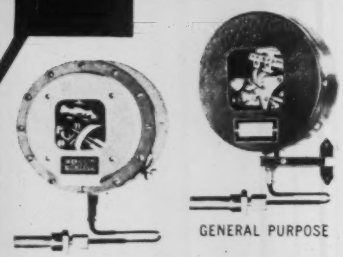
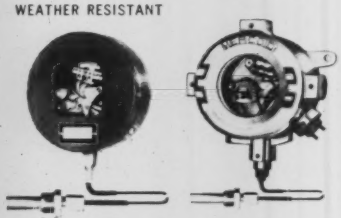
4 SERIES OF MERCOID TEMPERATURE CONTROLS



GENERAL PURPOSE

WEATHER RESISTANT



Two-Stage

EXPLOSION-PROOF

Each with these features:

External Adjustment
Sealed mercury contact
Visible calibrated dial
Visible on-off circuit
Repetitive trip point

Thirteen adjustable operating ranges from −60 +30° to 370-530°F.

Available in three case styles:
General Purpose (NEMA 1)
Weather-Proof (NEMA 1A, 2, 3, 4)
Explosion-Proof (NEMA 7, 9)

Series D-35 (10A. 115V., 5A. 230V.) Double adjustments for setting both high and low (on-off) operating points.

Series D-535 (close differential type) 5A. 115V., 2½A. 230V.) Double adjustment type for setting both high and low (on-off) operating points.

Series D-235 (very close differential type) 0.3A. 115V., 0.15A, 230V. Single adjustment for setting operating point only (minimum differential is factory set).

Series D-435 (Two-Stage Type) operates two SP-ST magnetic mercury switches at different temperatures to provide stage operation.

Write for
CATALOG NO. 860
THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

WE HEAR THAT . . .

▸ *TRION INC.'s* Mobile Clean Air Laboratory has completed a 13,000 mile, 47 city trip aimed at alerting people to the dangers of air pollution and the promotion of electronic air cleaning.

▸ *FOOD MACHINERY & CHEMICAL CORP.* has announced that its Peerless Pump Div., and seven associated operations will operate under the name *HYDRODYNAMICS DIV.*

▸ *CONSOLIDATED DIESEL ELECTRIC CORP.* has changed the collective reference name for its various operations to *THE CONDEC GROUP.*

▸ *HUPP CORP.* has acquired the manual valve operator business of *JONES MACHINERY DIV., HEWITT-ROBINS, INC.*

▸ *HAJOCA CORP.* has purchased *CRANE CO.'s* Trenton, N.J., branch.

▸ *THE NATIONAL BUREAU OF STANDARDS* is expanding its low-temperature research towards increasing temperature calibration precision in the approximate −300 to −425 F range, and towards extending the International Temperature scale below −300 F.

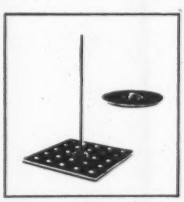
▸ *H. K. PORTER CO. INC.*, will invest approximately $4 million in new construction and equipment modernization of its Bessemer, Ala., and Wellsville, O. Refractories Div. plants.

(*Continued on page 223*)

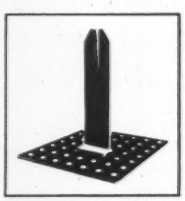
INSULATION INSTALLED FAST

WITH MIRACLE SURFACE ANCHORS

Use Miracle Surface Anchors, bonded with Miracle Anchor Adhesives, to provide firm support for block, board, or blanket type insulation. Eliminates drilling and welding. You save man hours, cut costs way down.



Use Spindle Anchors for bonding fibrous glass batts, mineral wool to ducts, walls, ceilings. Lock washer holds insulation firmly in place.



Use Pronged Anchors for bonding block insulation such as cellular glass. Pronged Anchors are set between rows of blocks and then prongs are bent over.

FREE

Valuable, informative engineers and architects bulletins giving details and complete specification data. Yours on request.

MIRACLE SURFACE ANCHORS
are manufactured by
DEVICES • Division of
MIRACLE ADHESIVES CORP.
250 Pettit Avenue
Bellmore, Long Island, New York

TWO VALVES REPLACED BY ONE DeZurik Valve with this adjustable stop ring.....

POSITIVE STOP AT THE BALANCED POSITION!

With this adjustable stop ring, *one* DeZurik Valve will replace the globe and gate combination often found on balancing service in air conditioning installations. Formerly, when the globe valves were set to balance the system, they could not be disturbed. If the system had to be shut down for necessary maintenance, the gate valves were used.

Now . . . . with DeZurik Valves installed on balancing service . . . . ONE valve replaces TWO! When the DeZurik Valve is set to the balanced position, the adjustable stop ring is set. Now, should the system require maintenance the DeZurik Valve can be shut off — dead tight — and opened against the positive position stop without guessing, without memorizing dial settings, without re-balancing . . . . positively and accurately! It *can't* be opened beyond the balanced position!

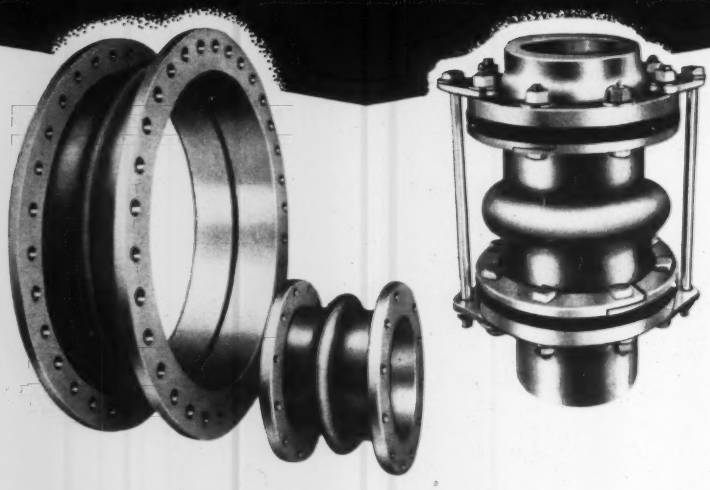
And here's another EXTRA advantage of DeZurik Balancing Valves: They're equipped with a pressure gage connection in the valve body, eliminating drilling or welding of the pipe and assuring an always-accessible location of the connection.

Get the *complete* story on DeZurik Valves; it will prove to you why DeZurik Valves are — obviously — the BEST VALVES FOR AIR CONDITIONING!

DeZurik Valves are available in sizes 1/2" thru 20", in 2-way, 3-way or 4-way models, with manual operation, on-off or positioning actuators. See the DeZurik representative in your area or write for details.

DeZURIK CORPORATION
SARTELL, MINNESOTA

R/M Rubber Expansion Joints and Pipe Solve Piping Stress and Vibration Problems



R/M Rubber Expansion Joints *absorb* pipe movement. They respond to the slightest pressure . . . preventing stress and strain on pipe and fittings that can cause major trouble in ventilating and air conditioning systems. R/M Rubber Joints also *insulate* system components against destructive vibration and noise. Where space is limited or equipment is operated above rated capacity, R/M Rubber Expansion Joints compensate for misalignment due to stress loading. They are available in a wide range of natural and synthetic rubber types for use with gases, fluids or semi-fluids over a temperature range to 200° F.

Condor Flexible Rubber Pipe is ideal for pipe lines subject to noise, vibration, electrolysis, corrosion, abrasion or taking backbends. It will outlast iron or steel—eliminate leaky joints at bends. Let an R/M Distributor discuss with you the advantages of R/M Rubber Expansion Joints, Condor Flexible Rubber Pipe and other R/M rubber products for your heating and cooling applications. Write for Bulletin M685.

R/M POLY-V® DRIVE

Single, Parallel V-Ribbed Belt

- MORE POWER—LESS SPACE
- CONSTANT SPEED RATIO
- ELIMINATES MULTIPLE V-BELT "MATCHING" PROBLEMS
- MAINTAINS GROOVE SHAPE
- LESS BELT AND SHEAVE WEAR
- LESS INVENTORY (2 cross sections instead of 5)

CONVERT TO POLY-V and BE SURE!

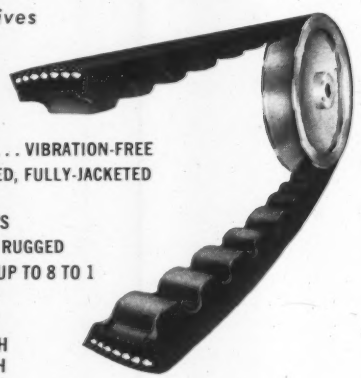
CONDOR V-BELTS

For Heavy Industrial Multiple Belt Units

- 40% MORE H.P. AT STANDARD V-BELT PRICE
- PRECISION MADE
- SMOOTHEST RUNNING V-BELTS MADE
- MORE GRIP, LESS SLIP
- LONGER, TROUBLE-FREE SERVICE
- LOWER DRIVE COSTS

*NEW R/M CX V-BELT**

For Light Duty Drives



- EXTREMELY QUIET . . . VIBRATION-FREE
- ONLY FULLY-MOLDED, FULLY-JACKETED LUGGED V-BELT
- FOR SMALL PULLEYS
- FLEXIBLE, STRONG, RUGGED
- OUTLASTS OTHERS UP TO 8 TO 1
- NO FLEX-CRACKING
- HOLDS SHAPE AND EFFECTIVE LENGTH WITHOUT STRETCH

*Made for original equipment. Patented.

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM1005
ENGINEERED RUBBER PRODUCTS . . . MORE USE PER DOLLAR

Dwyer
CONTROLS GAGES

AIR VELOCITY METER
No. 400

One Instrument Tells Both Air Velocity and Static Pressure!

- Reads directly in feet per minute and inches of water.
- Check *all* velocities from 400 to 10,000 F.P.M.
- All static pressures from 0 to 10" of water.

Tests fan and blower discharge and inlet pressures, pressure drop across filters, balances air conditioning systems, etc. Complete kit includes dual purpose manometer, 18" stainless steel pitot tube, Magneclip mounting panel and all necessary fittings, tubings, instructions and accessories.

Write today for literature and prices.

F. W. DWYER MFG. CO.
P.O. Box 373-H Michigan City, Ind.

WE HEAR THAT

Continued from page 220

▸ *JOHN WOOD CO.* has organized a new air pollution control div. at Bernardsville, N.J.

▸ *RHEEM MFG. CO.* has acquired control of *RUUD MFG. CO.* in a combination cash and stock transaction, and will operate Ruud as a division.

▸ *THE MATHES CO.*, division of *GLEN ALDEN CORP.*, has consolidated its business offices at new facilities in Marble Falls, Tex.

▸ *DEARBORN CHEMICAL CO.* has announced the opening of an Indiana-Michigan District Office in Fort Wayne, Indiana.

▸ *TURNER CONSTRUCTION CO.* will be general contractors for *ALUMINUM CO. OF AMERICA's* Merwin, Pa., research and development center.

▸ *MC JUNKIN CORP.* has reportedly absorbed its Pittsburgh subsidiary, *CHANDLER-BOYD CO.*, which will operate as McJunkin's Pittsburgh branch.

▸ *LIMBACH CO.* has been awarded construction contracts totaling $7 million for construction of two buildings in Indianapolis, Ind., one to be the Indianapolis City-County Building, the other to be an office building for the State of Indiana.

▸ *KARL F. LUKENS*, vice president in charge of sales with *WHEATLAND TUBE CO.* has been honored by the firm for 40 years of service.

4-D

WROUGHT IRON PIPE SOIL, WASTE, VENTS AND DOWNSPOUTS cuts maintenance/ installation costs

HERE'S WHY:

- optimum corrosion resistance
- needs no protective coating
- meets building code requirements
- resists shock and vibration
- saves space as Durham system
- long random lengths available
- fewer joints required
- fewer hangers needed
- less labor expended
- leak-proof sanitary joints
- no internal flaking, clogging
- low cost per year of service

Write for technical data on specific applications

BYERS 4-D WROUGHT IRON

Tubular and Flat Rolled Products
A. M. Byers Co., Pittsburgh 22, Pa.

2888

SINCE 1902 **Klipfel**

VALVES

AUTOMATIC CONTROL

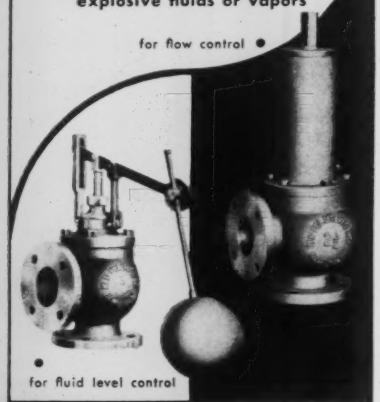
of

TEMPERATURE • PRESSURE
FLUID LEVEL • FLOW

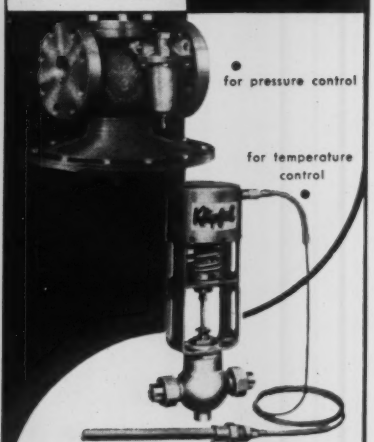
of

STEAM • GAS • AIR • WATER
viscous or abrasive sludges
CHEMICALS
explosive fluids or vapors

for flow control •



• for fluid level control



• for pressure control

for temperature control •

Special designs for application to original equipment. ENGINEERING

In writing for data please state your problem or describe your application. We will provide complete information.

Klipfel
VALVES INCORPORATED
1070 LINCOLN AVENUE
HAMILTON, OHIO
A DIVISION OF THE HAMILTON-THOMAS CORPORATION

WE HEAR THAT

Continued

▸ *AMERICAN METAL PRODUCTS CO.* has announced the transfer to its subsidiary *TUBE REDUCING CORP.* of all activities of its *DAVIS ENGINEERING DIV.*

▸ *FRANK D. MC BRIDE* has celebrated his 50th anniversary as president of *AMERICAN SOLDER & FLUX CO.*

▸ *HOUGHTON LABORATORIES* of Olean, N.Y., has changed its name to *HYSOL CORP.*

▸ *FRED S. DUBIN ASSOCIATES*, Consulting Engineers, have moved their home offices to new quarters at 635 Farmington Ave., Hartford, Conn.

▸ *THE CARWIN CO.* has absorbed its wholly owned subsidiary *CARWIN POLYMER PRODUCTS INC.*, the activities of which will be continued by Carwin's Polymer Products Div.

▸ *COLORADO RESEARCH CORP.*, former subsidiary of Carrier Corp., has been purchased by *BELL & GOSSETT CO.*

▸ *MELVIN H. FRIEDMAN & ASSOCIATES*, Engineers, have established a Rockland County Office at New City, New York.

▸ *L. S. (PAT) REAGAN*, president and director, *WEBSTER ENGINEERING CO.*, has retired after 32 years of service, and will participate in a consulting service in Tulsa, Okla.

Install Insulation with

TUFF-BOND

Super-Strength Adhesives

TUFF-BOND #7
... fire-retardant adhesive for installing insulation

TUFF-BOND M-102-H
... economical duct liner adhesive

TUFF-BOND 21-C
... clear lap sealer and lap adhesive

TUFF-BOND 21-W
... white lap sealer and lap adhesive

TUFF-BOND #500
... exceptionally high-strength chemical-set adhesive with wide thermal range −100° F. to 350° F.

TUFF-BOND #1000
... high heat resistance for bedding and installing high temperature insulation

TUFF-BOND #12
... high pressure duct sealer

TUFF-BOND QUIK-SET
... neoprene-base, fast-setting adhesive. Recommended for installing metal and nylon hangers to smooth surfaces.

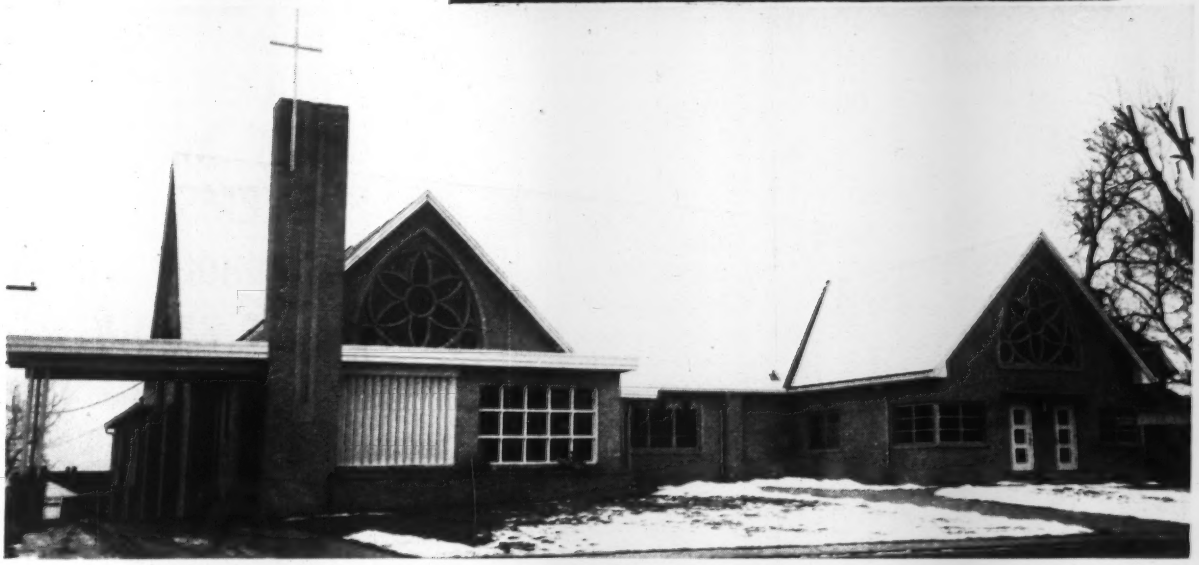
TUFF-BOND GENERAL PURPOSE IMPROVED
... all-around adhesive for installing insulation, insulation hangers, etc.

Ask for descriptive literature and prices.

GOODLOE E. MOORE
INCORPORATED
DANVILLE 26, ILLINOIS

Campbell

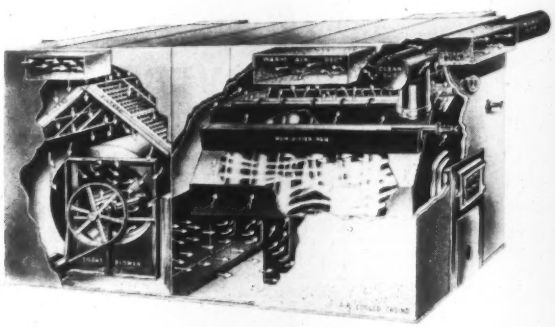
WARM AIR HEATERS FOR LARGE BUILDINGS



Methodist Church, Carroll, Iowa, economically heated with a Campbell #8125 combination gas-oil fired unit, installed in 1956. Heating contractor, Drees Plumbing & Heating, Carroll. Architect, The Griffith Company, Fort Dodge, Iowa.

ECONOMICAL CHURCH HEATING

Campbell warm air heaters deliver the maximum in economy and flexibility for church heating. Low in first cost, easy to install, and remarkably economical to operate. They deliver the quick, abundant heat needed for the "on and off" operation that is characteristic in churches. Extremely quiet! Available for all fuels in capacities up to 3,150,000 BTUs.



MANUFACTURERS' AGENTS

We have some very attractive openings for men calling on heating contractors and architects.

CAMPBELL HEATING COMPANY

Des Moines 17, Iowa

AirMpeler

LO-BOY
CENTRIFUGAL ROOF EXHAUSTERS

Enhance the Beauty of Building Skylines

Pats. Pend.

Lowest Silhouette Design

Forward or Backward Curve Wheel Within . . . . or Out of Scroll Housing

Motor mounting on side of structure support . . . out of line of air stream reduces height of Lo-Boy models nearly 50% of older designs.

LOW WIND RESISTANCE
SIZES 10"-72" 600-47,000
CERTIFIED C.F.M. RATINGS

- **QUALITY**
- **BEAUTY**
- **PROVEN PERFORMANCE**

Write for bulletin Ha-100 60

AMMERMAN CO., INC.

P.O. Box 182
Stillwater, Minnesota
MEMBER OF THE AIR MOVING & CONDITIONING ASSN.

WE HEAR THAT

Continued

▸ *RECOLD CORP.* has begun manufacturing operations on its line of air conditioning and refrigeration products at new facilities in Columbus, Ohio.

▸ *MARSH INSTRUMENT CO.* has announced plans for an expansion program which will result in an increase of 40 percent of production capacity.

▸ *THE INSTITUTE OF BOILER AND RADIATOR MANUFACTURERS* has announced the approval of I-B-R ratings for commercial finned tube radiation units manufactured by 11 companies. Ratings will be supplied on request by the Institute at 608 Fifth Ave., New York 20.

▸ *WALWORTH CO.* has completed its first annual sales meeting for salesmen and company executives in Rockton, Ill.

▸ Twenty-one graduates of U.S. and Canadian colleges have completed the specialized engineering program conducted by *THE TRANE CO.* The six month program is designed to bridge the gap between scholastic background and assignment in the field.

▸ *CRANE CO.* has acquired *PIPE FABRICATORS, INC.*, of East Chicago, Ind. and *CANADIAN PITTSBURGH PIPING LTD.*, Hamilton, Ontario, Canada. Pipe Fabricators, Inc., will be operated as the Crane Co. Pipe Fabricating Div., and Canadian Pittsburgh Piping, Ltd. becomes a subsidiary known as Crane Piping Ltd.

▸ *ROSWELL FARNHAM*, Buffalo District Sales Manager, *BUFFALO FORGE CO.*, has retired after 46 years of service.

4-D

WROUGHT IRON SNOW MELTING SYSTEMS assure permanent winter traffic safety

WHERE TO USE IT:

- hazardous highway areas
- highway approaches
- toll booth areas
- airport runways
- hangar door aprons
- airport taxi strips
- passenger loading areas
- ramps
- "drive-in" banks
- driveways
- marquees, balconies
- loading docks
- sidewalks

WHY 4-D WROUGHT IRON?

- built-in corrosion resistance
- good heat transfer properties
- rugged strength
- crushproof
- no thermal stresses with concrete
- good bending properties
- welds soundly, easily
- leakproof
- lowest cost per year of service

Write for technical data on specific applications

BYERS 4-D WROUGHT IRON

Tubular and Flat Rolled Products

A. M. Byers Co., Pittsburgh 22, Pa.

Send for This Useful Reprint Volume

"Correct Practice in Industrial Piping"

— All-New Third Edition —
196 Pages — 8½" x 11" — $1.50

This practical book is made up of outstanding papers and data on industrial piping selected from past issues of "Heating, Piping & Air Conditioning." It is a most comprehensive collection of case studies, showing how various difficult piping problems encountered in different industrial plants were successfully worked out by piping experts.

Design, installation, operation, and maintenance . . . steam, air, gas, oil, process, water and refrigeration piping . . . piping in pulp and paper and steel mills, in automobile plants and breweries, in the food and chemical and textile industries, and in many other types of manufacturing plants are dealt with from many different angles.

Send $1.50 today for this book to the address below:

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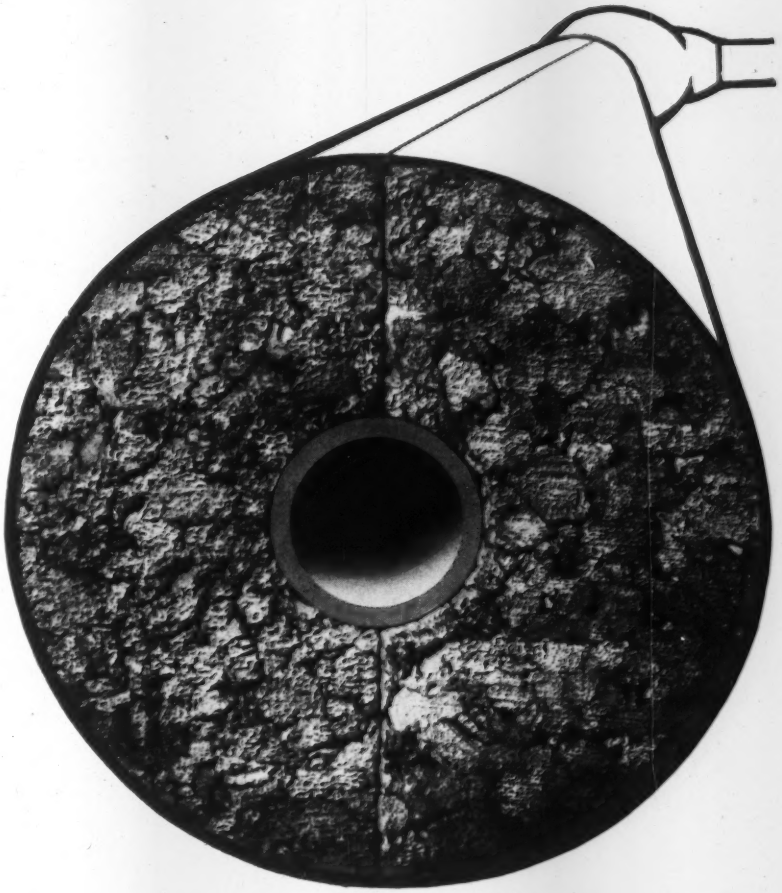
Publishing Company

6 North Michigan Ave., Chicago 2, Ill.



United's Molded Cork Pipe Covering

FITS TIGHTER . . . GOES ON FASTER . . . PROVIDES MAXIMUM PROTECTION — When it comes to advantages, no other product can match *all* the benefits of United Cork's Molded Pipe Covering. Made from pure, clean, granulated cork, compressed and molded to exact size and shape and finished with a coating of plastic asphalt, it is an ideal covering for brine, ammonia, ice water, and cold lines of every kind. It has an extremely stable K factor over a wide low temperature range, will not rot or support combustion and is clean, sanitary and odor free. It is easy to install . . . and in the long run it's the least expensive.

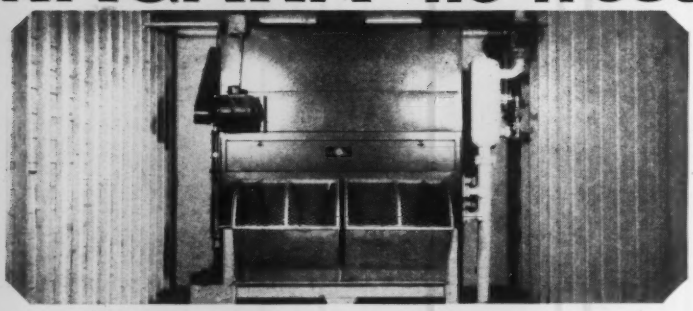
Available in a wide variety of sizes and shapes from local stocks in key areas, coast to coast. Write today for more complete information as well as helpful installation data.

UNITED BB CORKBOARD

UNITED CORK COMPANIES
Since 1907
1 Central Avenue, Kearny, N. J.

Engineering offices or approved distributors in key cities — coast to coast.

NIAGARA "no frost"



GET THE BEST QUALITY IN FROZEN FOOD

● Operating men, who know both costs and profits, will tell you that Niagara "No-Frost" gives you the best operation in frozen foods... both in freezing and in warehousing where trustworthy, safe storage temperatures must be combined with building layout that lets you *move* goods... not just store them. Only Niagara methods give you safe and even temperatures with over 20′ head room so that you can use your fork lift trucks and palletized warehousing efficiently. And "No-Frost" refrigeration shows the lowest upkeep costs in the business.

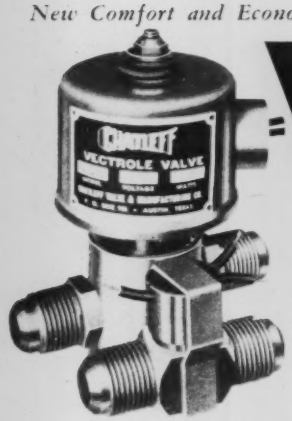
Write for Bulletin No. 105

NIAGARA BLOWER COMPANY

Dept. HP-3, 405 Lexington Ave., New York 17, N. Y.

District Engineers in Principal Cities

New Comfort and Economy For Individual Forced Air Convectors.



The Vectrole Water Diverting Valve

gives you year 'round comfort automation at a reasonable price. The Chatleff Vectrole Valve, Switching Element and Thermostat give you a complete comfort control system at a tremendous saving.

Please send me complete information on the Chatleff Vectrole Valve.

Name

Address City

CHATLEFF VALVE & MANUFACTURING CO.

205 Industrial Blvd. Austin 4, Texas

WHO'S WHAT...

(new personnel, promotions)

▸ *NATIONAL COAL ASSOCIATION*—Carroll F. Hardy, director, Bituminous Coal Institute Div.; Harry C. Ballman, director, Air Pollution Control Div.; Paul L. Brown, director, Manpower Development Div.

▸ *PITTSBURGH CORNING CORP.*—Frank R. Maston, secretary.

▸ *BUFFALO FORGE CO.*—Milford E. Reiner to Board of Directors.

▸ *WALTON LABORATORIES INC.*—John B. Feldermann, president.

▸ *WARREN WEBSTER & CO., INC.*—Don F. Bennett, assistant vice president of marketing; James J. Bubser, product sales manager for radiation and steam specialties.

▸ *ARKLA AIR CONDITIONING CORP.*—Bohdan G. Passty, development engineer in charge of Humphrey Heating Div.

▸ *THE BLACK & DECKER MFG. CO.*—Glen H. Treslar, general sales manager, Industrial-Automotive Div.

▸ *YOUNGSTOWN SHEET AND TUBE CO.*—John P. DeHetre, general manager, sales; William E. Farragher, Jr., advertising manager.

▸ *AMERICAN AIR FILTER CO. INC.*—James F. Fish, manager, Commercial Portable Products Dept.

WHO'S WHAT

Continued

▸ *H. K. PORTER CO., INC.*—James H. Wyres, general sales manager, Forge & Fittings Div.

▸ *CONTROLS CO. OF AMERICA*—Harold Taylor Ames, to board of directors.

▸ *INSUL-MASTIC, INC.*—Richard R. Rue, plant manager.

▸ *W. D. ALLEN MFG. CO.*—H. E. Meng, Honorary Chairman; E. H. Nelson, chairman; A. D. Symonds, president; W. F. Symonds, executive vice president and secretary.

▸ *AIR REDUCTION SALES CO.*—C. H. Glasier, executive vice president.

▸ *L. J. WING MFG. CO.*—Adolph R. Schaub, manufacturing manager.

▸ *MANNING, MAXWELL & MOORE, INC.*—F. James Murphy, product manager, Industrial Instruments Div.

▸ *KENNEDY VALVE MFG. CO.*—sales vice president James R. Erven to board of directors.

▸ *ROBERT E. HATTIS ENGINEERS INC.*—Michael F. Stearn, vice president in charge of design.

▸ *RHEEM MFG. CO.*—Gordon W. Mallatratt, vice president, finance; Robert T. Stroup, treasurer.

In HTW Generation

*High Temperature Water

International-LaMont
LEADS THE WAY

TYPICAL INSTALLATIONS

INDUSTRIAL & COMMERCIAL
Douglas Aircraft Corp.
Continental Can Co.
Union Carbide Nuclear Co.
Behr-Manning Co.
Johnson & Johnson
American Airlines Inc.
Bethlehem Steel Co.
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Ohio National Life Insurance Co.
Trans-Canada Air Lines
Bethlehem Pacific Coast Steel Co.
International Min. & Chem. Corp.

HOSPITALS
N. E. Florida Mental Hospital, Fla.
The Children's Hospital, Ohio
Bronx State Hospital, N. Y.
Loring AFB Hospital, Me.
Hadassah-Hebrew Medical Center, Israel

SCHOOLS & UNIVERSITIES
Rutgers University, N. J.
Hilltop Elem. School, Ohio
American River Jr. College, Cal.
Madeira High School, Ohio
Brigham Young University, Utah
Indian Hill Elem. School, Ohio
Holy Apostles School, Wisc.
Maple Park Elem. School, Ohio
Everett High School, Mich.
Avondale Elem. School, Ohio
Utica Jr. High School, Mich.
Whitewater High School, Wisc.
College of Great Falls, Mont.
The Colorado College, Colo.
St. Joseph Seminary, La.
Blossom Hill School, Ohio
Plus 21 U. S. Air Force and Navy Bases.

More than 130 International-LaMont High Temperature Water Generators already in operation have a total capacity exceeding THREE BILLION Btu/hr.

This unequalled acceptance underlines a significant point. It is not enough merely to heat and distribute water at temperatures to 430° F. or more. The *real* economy of HTW is in the *magnitude* of the temperature differential between boiler discharge and return water.

Making full use of the proven LaMont principles of forced recirculation, International-LaMont Generators permit temperature differentials to 200° F. or more with *no danger of thermal shock*. Here is the key to major capital and operational savings throughout the system. In addition, International-LaMont counterflow design assures optimum heat absorption and high operating efficiency.

Investigate the *true* economy of high temperature water in terms of International-LaMont Forced Recirculation Generators.

Get full details from your
INTERNATIONAL DISTRICT REPRESENTATIVE
or write for Bulletins 700 and 1000 today.

IBW
BOILER BUILDERS SINCE 1886

THE INTERNATIONAL BOILER WORKS CO.

Steel Firebox Heating & Power Boilers
Low & High Pressure Water Tube Package Boilers • International-LaMont Forced Recirculation Generators • ASME Code Pressure Vessels & Welded Products.

810 Spruce St. East Stroudsburg, Pa.

Manufactured and sold in Canada under agreement with CANADIAN VICKERS LTD. Montreal, P. Q.

800 to 1 hp favorites for quiet operation, low maintenance and long-life service . . .

From the case of the A. O. Smith Motor Man — a complete stable of integrals that include single-phase models (1-5 hp) or polyphase (1-800 hp). Also a team of fractional-hp motors. All are sure bets to give top performance over the long, long haul.

And there's an A. O. Smith Motor Man near you — chomping at the bit to give you 24-hour action on all parts and service orders.

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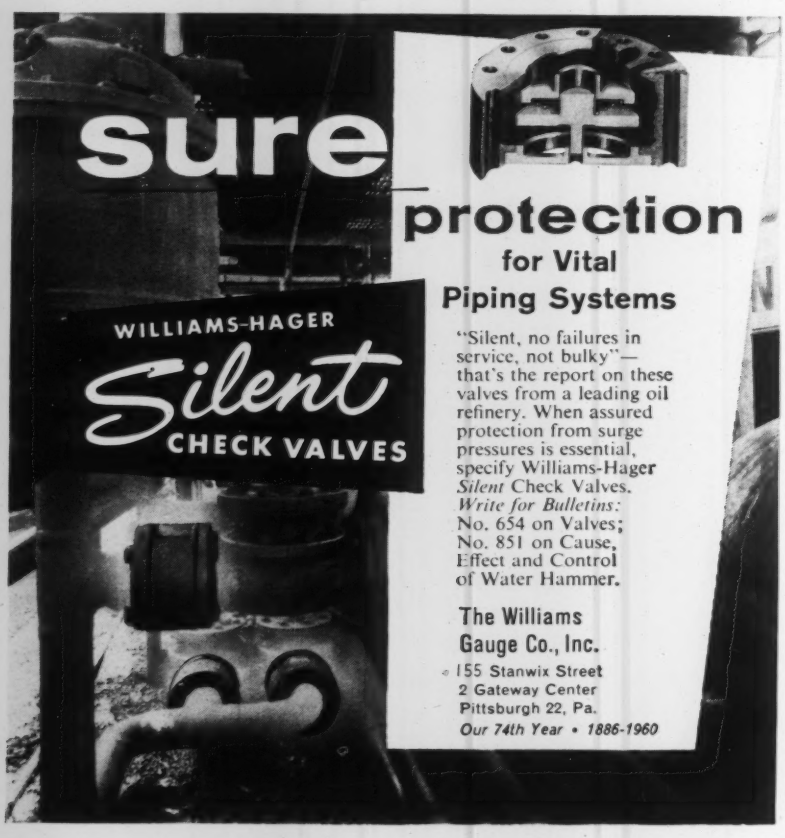
Through research ... a better way

A.O.Smith
CORPORATION
ELECTRIC MOTORS
Tipp City, Ohio
A. O. SMITH INTERNATIONAL, S.A.
Milwaukee 1, Wisconsin, U.S.A.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protection
for Vital
Piping Systems
WILLIAMS-HAGER
Silent
CHECK VALVES
"Silent, no failures in service, not bulky"— that's the report on these valves from a leading oil refinery. When assured protection from surge pressures is essential, specify Williams-Hager *Silent* Check Valves. *Write for Bulletins:* No. 654 on Valves; No. 851 on Cause, Effect and Control of Water Hammer.
The Williams Gauge Co., Inc.
155 Stanwix Street
2 Gateway Center
Pittsburgh 22, Pa.
Our 74th Year • 1886-1960

WHO'S WHAT

Continued

▸ *GENERAL CONTROLS CO.*—John E. Charsha, Jr., sales manager, Hammel-Dahl Div.

▸ *REVCOR, INC.*—Charles Wilson, nationl sales manager.

▸ *AMERICAN RADIATOR & STANDARD SANITARY CORP.*—John R. Warnock, Richard L. Campbell, George F. Butterfield, elevated to vice presidents.

▸ *BENJAMIN FOSTER CO.*—George Foster, Jr., vice president in charge of sales.

▸ *TUBE TURNS PLASTICS, INC.*—Earl A. Erich, vice president.

▸ *RECOLD CORP.*—C. Milton Wilson, general sales manager, Air Conditioning Div.

▸ *DUNHAM-BUSH, INC.*—Aden H. Maben, assistant advertising manager.

▸ *THOR POWER TOOL CO.*—John P. Bank, national service manager.

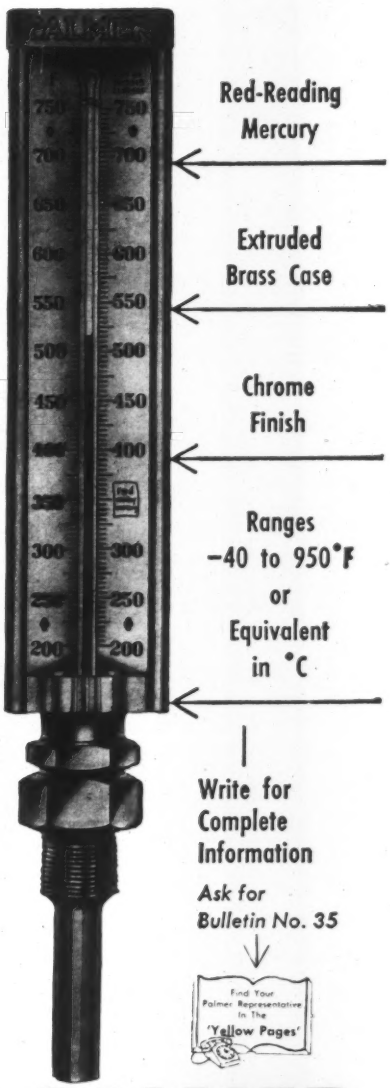
▸ *LIBBEY-OWENS-FORD GLASS CO.*—Dr. Donald R. Martin, director of research.

▸ *INSTRUMENT SOCIETY OF AMERICA*—Donald F. Adams, chairman, air pollution instrumentation committee.

Today's Modern Industry
Demands a Modern Thermometer

PALMER

RED-READING MERCURY THERMOMETERS



Write for Complete Information

Ask for Bulletin No. 35

Find Your Palmer Representative In The 'Yellow Pages'

PALMER

THERMOMETERS, INC.
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers
Cincinnati 12, O.

WHO'S WHAT

Continued

▸ *TUBE REDUCING CORP.*—A. O. Jaeckel, vice president and general manager, Davis Engineering Div.

▸ *ARMCO STEEL CORP.*—G. W. Breiel, manager, sales administration, Armco Div.

▸ *CORNELL & UNDERHILL, INC.*—W. Richard Kitchen, vice president and manager of sales.

▸ *MINNEAPOLIS-HONEYWELL REGULATOR CO.*—Stephen F. Keating to board of directors.

▸ *FAIRBANKS, MORSE & CO.*—Gordon Rowen Anderson, executive vice president, operations.

▸ *THE RAWLPLUG CO., INC.*—Norman C. Macdonald, sales manager; James E. Burke, assistant sales manager.

▸ *THE TORRINGTON MFG. CO.*—Charles A. Hathaway, assistant general manager, Air Impeller Div.

▸ *THE AUSTIN CO.*—John N. Beckley to board of directors; Rollin R. Eiber, vice president.

▸ *WRIGHT-TEMP MFG. CO.*—W. W. Wallace, executive vice president.

▸ *FRED S. DUBIN ASSOCIATES*—James H. Quinlan appointed to associate.

4-D

WROUGHT IRON IN BUILDING PIPING provides lowest cost per year of service

WHERE TO USE IT:

- soil lines
- waste lines
- vent piping
- downspouts
- steam supply lines
- steam condensate returns
- electrical conduit
- hot and cold water lines
- underground lines
- cooling tower piping
- radiant heating systems
- snow melting systems
- sprinkler systems
- air conditioning systems
- refrigeration

Write for technical data on specific applications

BYERS 4-D WROUGHT IRON

Tubular and Flat Rolled Products

A. M. Byers Co., Pittsburgh 22, Pa.

PRESSURE MEASUREMENT

ASHCROFT GAUGES DO THE JOB *ACCURATELY*

Ashcroft Duragauge in Phenol Case

Name the operational pressures of any heating, piping or air conditioning equipment you specify, install or service: There's an Ashcroft Gauge to measure the pressures precisely—from 30″ vacuum or a few ounces to the highest psi used on any system. That is why Ashcroft Gauges are used on everything from giant boilers to small compressors.

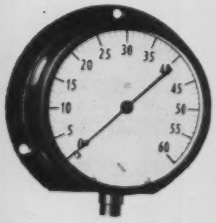
You have a choice of three classes of Ashcroft Gauges. Each class has functional characteristics compatible with its recommended applications.

DURAGAUGES: The finest pressure gauges you can specify and install on any heating, piping or air conditioning system. Highest sustained accuracy and durability assure savings in replacements and repairs far exceeding the initial investment.

QUALITY GAUGES: Second only to the Duragauge in ruggedness and sustained accuracy. Ideal for the normal industrial, commercial and institutional equipment.

STAINLESS STEEL CASE GAUGES: The best gauges for small compressors, pumps, boilers and the less important pressure lines. Inexpensive but accurate and durable.

Whatever the medium under pressure—air, oil, water, steam, or refrigerant—select Ashcroft Gauges. Pressure, vacuum and compound ranges available. Several dial sizes. *Write for Catalog 300B.*



Ashcroft Quality Gauge in Alumalife® Case. Catalog No. 1010.

Ashcroft Gauge in Stainless Steel Case. Catalog No. 1000.

ASHCROFT PRESSURE GAUGES
A product of
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

WHO'S WHAT

Continued

▸ *BUFFALO METER CO., INC.*—Herbert F. Barrett, general sales manager.

▸ *FAMILIAN PIPE & SUPPLY CO.*—Leonard Shapiro, president; Arnold Familian, executive vice president and director of sales.

▸ *DOVER CORP.*—Ernest M. Webb, field engineer, Peerless Mfg. Div.

▸ *SWAN MFG. CO.*—M. R. Van Zanten, president; William Leiner, vice president.

▸ *WORTHINGTON CORP.*—A. William Fraser, vice president and general sales manager.

▸ *CHRYSLER CORP., AIRTEMP DIV.*—Lawrence H. Baker, manager of branch sales.

▸ *CONNOR ENGINEERING CORP.*—James A. Gray, general sales manager.

▸ *THE TORRINGTON MFG. CO.*—Rufus C. Stillman, assistant to the president; Kenneth A. Merz, engineering manager, Air Impeller Div.

▸ *TRION, INC.*—Robert L. Anthony, advertising manager.

▸ *BUFFALO FORGE CO.*—Theodore M. Dillaway, vice president; George P. Schivley, vice president of manufacturing.

▸ *ARMCO STEEL CORP.*—Jay G. Jerry, supervisor of application engineering.

▸ *NATIONAL INSULATION MANUFACTURERS ASSOCIATION*—vice president: Hugh T. Williams, manager of engineering and industrial sales, Owens-Corning Fiberglas Corp.

▸ *AMERICAN STANDARD*—Charles H. Harper, director of industrial relations, Industrial Div.

▸ *JOSEPH T. RYERSON & SON, INC.*—Thomas Z. Hayward, senior vice president; Weaver E. Falberg, vice president, sales.

WHO'S WHAT

Continued

▸ *BELL & GOSSETT CO.*—William A. Boone, executive vice president and treasurer.

▸ *CALUMET & HECLA, INC.*—D. W. Blend, vice president of operations and director.

▸ *UTILITY FAN CORP.*—Marc McGuire, sales manager.

▸ *REVERE COPPER AND BRASS, INC.*—James S. Fidler, treasurer; William F. Collins, secretary.

▸ *COPELAND REFRIGERATION CORP.*—Ernest Kroder, chief engineer, standard products.

▸ *BABCOCK & WILCOX CO.*—Robert A. Barr, vice president.

▸ *RAYPAK CO., INC.*—Richard M. Norton, national sales manager.

▸ *HAMMOND VALVE CORP.*—Loren H. Bonnett, vice president, sales; William C. Peterson, vice president, manufacturing.

▸ *GRAVER WATER CONDITIONING CO.*—Marvin Lane, general manager.

▸ *MILTON ROY CO.*—Earl J. Serfass, vice president in charge of research and development and board of directors.

▸ *JOSAM MFG. CO.*—M. J. Hirshstein, president; A. L. Yeager, vice president in charge of manufacturing; Lewis H. Polster, vice president in charge of sales.

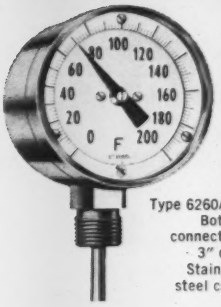
▸ *PERMAGLAS DIV., A. O. SMITH CORP.*—Walter M. Harris, controller; Robert M. Timmerman, manager of materials; Howard D. Tomas, manager of industrial relation.

▸ *KEASBEY & MATTISON CO.*—Andrew C. Richardson, merchandising manager, sprayed asbestos; William H. Mackey, merchandising manager, asphalt products dept.; Louis Voges, project engineer, central engineering dept.

▸ *SPECIALTY BLOWER DIV., TORRINGTON MFG. CO.*—Adam M. Wilczenski, manager, technical services.

TEMPERATURE MEASUREMENT

AMERICAN THERMOMETERS DO THE JOB *ACCURATELY*



Type 6260AH—Bottom connection. 3" dial. Stainless steel case.

They respond quickly and accurately to all temperature changes, whether mounted on a blower in a basement or on air conditioning equipment on a roof. American Bi-Metal Dial Thermometers combine superior resistance to vibration with the greatest sensitivity in bi-metal actuation. Two other advantages provide extra value:

ANTI-PARALLAX MAXIVISION® DIAL guarantees surest, sharpest, easiest readings. It is a split-level dial constructed with graduations and pointer on the same plane. No perspective effect. No parallax error in reading. Only American Thermometers have this feature.

WEATHERPROOF CONSTRUCTION seals out all atmospheric and application conditions that might cause erosion, corrosion, inaccuracy and shorten service life.

Wherever accurate temperature measurements are essential—whatever the operational temperatures of the heating or air conditioning system — choose American Thermometers. Mounting styles include the "Every Angle" thermometer you can set for face-to-face readings wherever installed. Dial sizes, temperature ranges and stem lengths to meet your needs exactly. *Write for Catalog 100.*

Type 6360AH — Back connection. 3" and 5" dials. Stainless steel case.

Type 6060AH—"Every Angle" connection permits setting at any point within 180° on two axes. 5" dial. Stainless steel case.

Type 6360AH — Back connection. 2" dial permits installation in close quarters without sacrificing readability. Stainless steel case.

AMERICAN THERMOMETERS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

WHO'S WHAT

Continued

▶ *TUBE MANIFOLD CORP.*—John D. Amoroso, plant manager.

▶ *MINNEAPOLIS-HONEYWELL REGULATOR CO.*—Douglas K. Ridley, contract sales manager.

▶ *TRANE CO.*—Sam H. Harper, Jr., sales engineer.

▶ *ARCRODS CORP.*—H. M. Peterson, vice president and controller.

▶ *BABCOCK & WILCOX CO.*—J. R. Connell, purchasing agent of the boiler division; J. P. Craven, vice president; O. R. Carpenter, assistant vice president, boiler division.

▶ *BROWN FINTUBE CO.*—John W. Nevins, chief engineer.

▶ *ELLIOTT CO., DIV. OF CARRIER CORP.*—Frank M. Fives and Walter A. Snow, sales and engineering managers, respectively, to head new industrial air and gas compressor dept.

▶ *BLACK & DECKER MFG. CO.*—Harry L. Williamson, Jr., vice president and general manager of Master Power Corp. subsidiary.

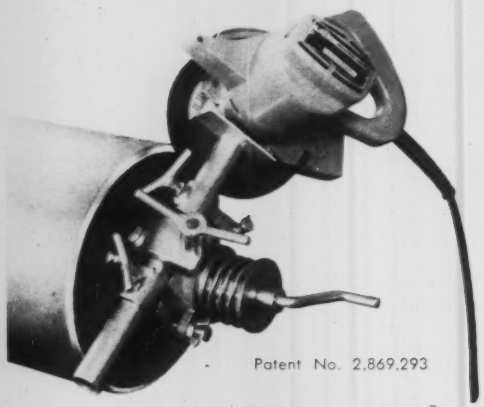
▶ *VIKING AIR PRODUCTS DIV., NATIONAL-U.S. RADIATOR CORP.*—John A. Green, general sales manager.

▶ *CLEAVER-BROOKS CO.*—Donald W. Mattimore, supervisor of water tube boiler erection for Springfield Boiler Co. subsidiary.

▶ *MIDLAND-ROSS CORP.*—Henry M. Heyn, vice president in charge of Surface Combustion Div.; Robin A. Bell, vice president in charge of Janitrol Heating and Air Conditioning and Janitrol Aircraft Divs.; Eugene P. Heiles, vice president of Surface Industrial Div.; Robert J. Jacobs, vice president in charge of Waldron-Hartig Div.; C. J. Schmidt, vice president.

▶ *AMERICAN GAGE & MACHINE CO.*—William F. Huck, director.

• *for fast cleaning of pipe cuts . . .*
• *for accurate placing of lands on pipe bevels . . .*



Patent No. 2,869,293

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LIGHTWEIGHT! EASY TO OPERATE!

Eliminates Handwork on all Types of Pipe from 6" to 30"

The new H&M "BEVEL-LAND" GRINDER uses an electric or airpowered grinder to prepare pipe for welding by cleaning and smoothing pipe cuts and putting the land on bevels. The GRINDER may be placed in the pipe and in operation in a few seconds. A simple adjustment of the angle of the grinding head is all that is required to change the machine from the cleaning to the land position. The machine is available in two models: one for 6" to 12" and one for 14" to 30" pipe.

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TULSA, OKLAHOMA

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WHO'S WHAT

Continued

▶ *MONTGOMERY ENGINEERING CO.*—Irving S. Phillips, president.

▶ *AIR MOVING AND CONDITIONING ASSN., INC.*—president: Earl E. Trickler, vice president of marketing, New York Blower Co.

▶ *AIR FILTER CORP.*—Robert Zahn, vice president and general manager.

▶ *L. J. WING MFG. CO.*—Crawford E. Steiss, vice president for sales.

▶ *REZNOR MFG. CO.*—William C. Schodlatz, vice president, personnel and administration.

▶ *NATIONAL HUMIDIFICATION ASSN.*—George Boeddner, executive vice president, retired as managing director of National Warm Air Heating and Air Conditioning Assn.; other officers: president: Joseph Perlman, Auto-Flo Corp.; vice president: James Madden, Maid-O-Mist Corp.; secretary: Morris Margolis; treasurer: Jack Green, Viking Air Products.

▶ *ACME INDUSTRIES, INC.*—Robert C. Robertson, vice president in charge of sales; Walter M. Hassenplug, to board of directors.

▶ *AMERICAN-STANDARD INDUSTRIAL DIV.*—Harley W. McClure, product manager in charge of boiler products; John F. Tobin, vice president - marketing.

▶ *ARKLA AIR CONDITIONING CORP.*—Russell Lloyd Brown, manager, heating and air conditioning products.

▶ *BOHN ALUMINUM & BRASS CORP.*—Edward N. Harris, manager, South Haven, Mich. plant.

▶ *MANNING, MAXWELL & MOORE*—John F. Reed, executive vice president and member of board; John A. Flynn, vice president.

▶ *LAU BLOWER CO.*—Ralph Weaver, manager, market research.

▶ *DRAVO CORP.*—H. R. Mantle, asst. to president.

usAIRco

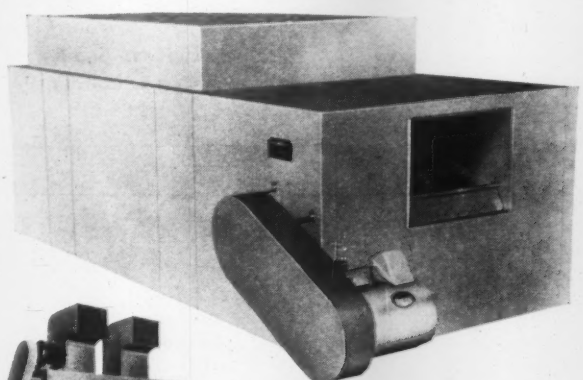
sectional heating and air conditioning units offer complete

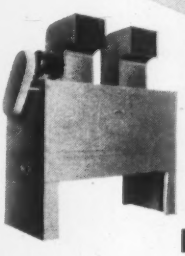
FLEXIBILITY

Select the exact equipment required to custom engineer each installation

A variety of sizes for commercial and industrial applications. Available for vertical or horizontal mounting with many choices of motor and discharge positions.

A wide selection of heat transfer coils.





SECTIONAL AIR CONDITIONER
Model BC,
1,200 CFM to 22,000 CFM

HEATING and VENTILATING
Model BH
1,200 CFM to 28,000 CFM

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usAIRco

Product Bulletin #74
Sectional Air Conditioner
Model BC

Product Bulletin #73
Heating and Ventilating
Model BH

United States Air Conditioning Corporation
Delaware, Ohio

WHO'S WHAT

Continued

▸ *ALPHA METALS, INC.*—Harold Hertzog, president; Martin A. Boyle, vice president, sales; Rena Shonberg, secretary-treasurer.

▸ *WAGNER ELECTRIC CORP.*—Harold N. Felton, vice president, marketing, and member, board of directors; Carl E. Widell, assistant vice president, marketing; Ralph W. Boeringer, vice president, industrial relations; Harold S. Garrett, director of purchases.

IN THE TERRITORIES . . .

(Recent sales appointments)

▸ *LAU BLOWER CO.*—Wes Piercey, northwestern territory representative.

▸ *NATIONAL LOCK CO.*—Glen M. Heimert, industrial div. sales representative for southern California.

▸ *ELGEN MFG. CORP.*—Vincent E. Devine, representative in Pennsylvania area; L. E. Schulein, Chicago representative.

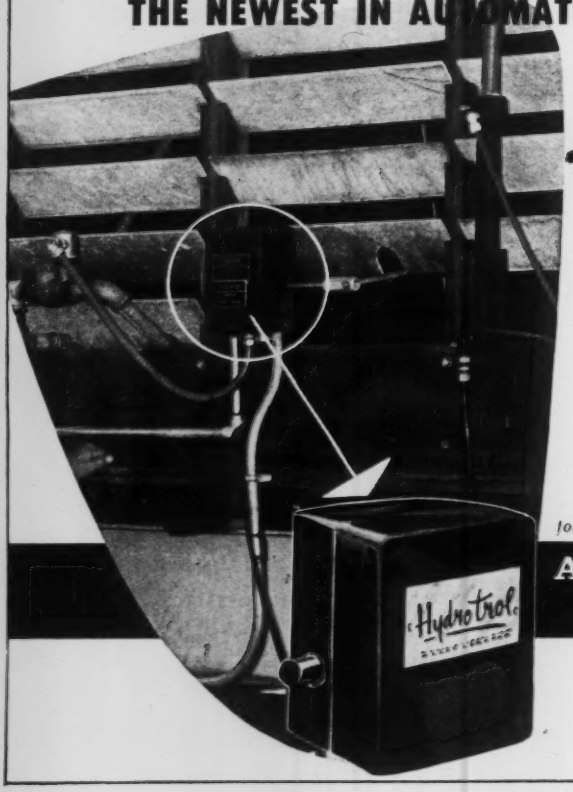
▸ *TEXAS INSTRUMENTS, INC.*—Dugald B. Roy, district sales engineer; Robert G. McCoy, field sales engineer, Los Angeles area, James R. Marquart, field sales engineer, Louisville area.

▸ *AVCO CORP.*—N. M. Cott, sales agent in metropolitan New York for Spencer Heater, Lycoming Div.

▸ *TUBE MANIFOLD CORP.*—Arthur K. Johnston, sales representative in Washington, Oregon, Idaho, parts of provinces of British Columbia and Alberta.

▸ *E. I. du PONT de NEMOURS & CO.*—Lewis G. Kirk, sales representative, Chicago district; Peter V. Ricciardi, sales representative, New York district; Lammot D. Copeland, Jr., sales correspondent, western district.

THE NEWEST IN AUTOMATION FOR COOLING TOWERS . . .



Hydrotrol

AUTOMATIC WATER TREATMENT

ADDS TREATMENT AND CONTROLS CONCENTRATIONS AUTOMATICALLY IN DIRECT PROPORTION TO "MAKE-UP" WATER . . . REGARDLESS OF EVAPORATION.

- ECONOMICAL
- For use on 20 ton to 2000 ton TOWERS
- Direct Tower Treatment Feed — OR — remote treatment feed to circulating line
- Fully AUTOMATIC
- EXCLUSIVE — the only equipment of its type.

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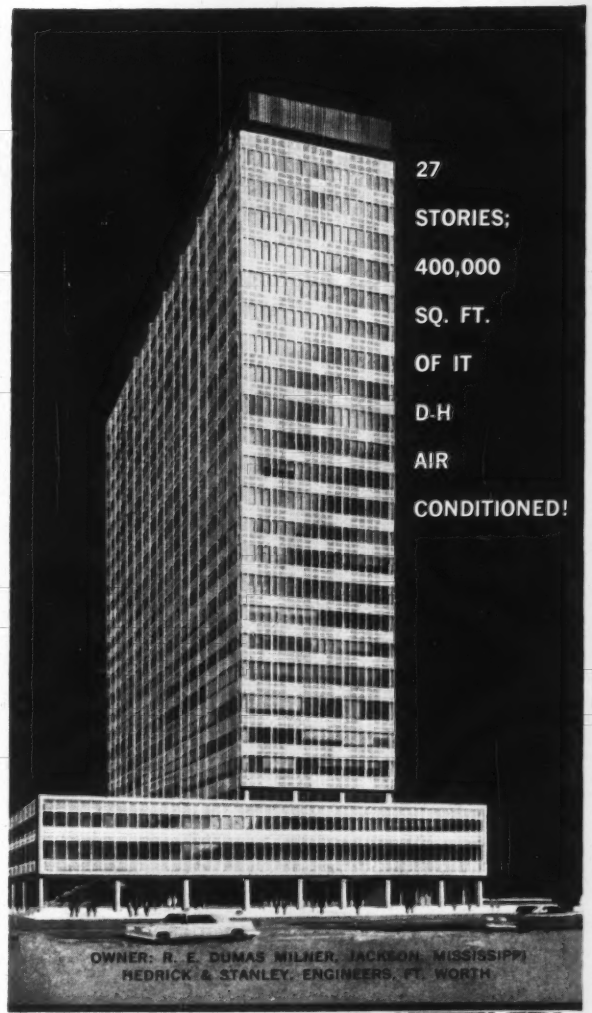

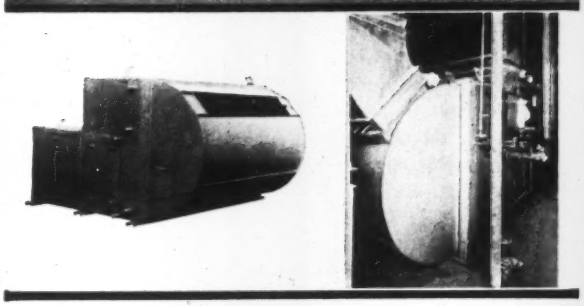

24 PACE-SETTING NEW D-H HIGH
PRESSURE H.C.D. AIR HANDLERS DO IT
...AT NEW KROGER BLDG., CINCINNATI.

NEED LITERATURE?

d-h drayer-hanson
DIVISION NATIONAL U.S. RADIATOR CORP

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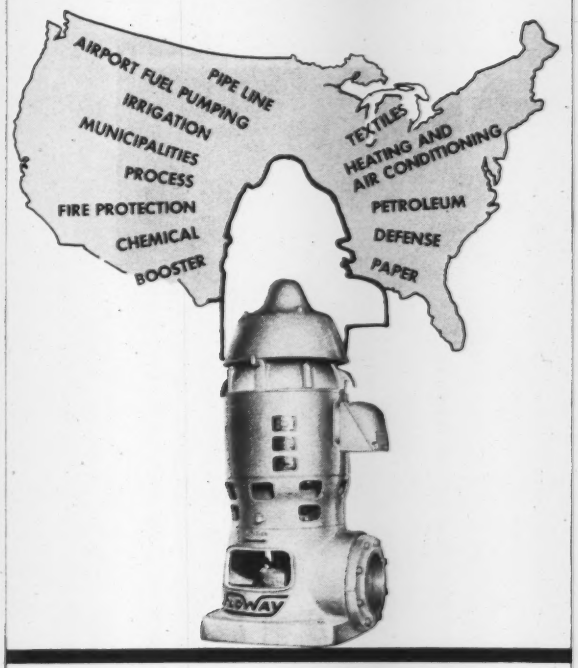
CABLE: CLICONI, LOS ANGELES

VERTICAL TURBINE PUMPS

FLOWAY
formerly SMITHway

Fit The Market



FloWay pumps are serving every industrial pumping need, serving well because they are designed and constructed for specific requirements. Whether the liquid is in the extremes of heat or cold, corrosive or non-corrosive, volatile or non-volatile, there is a FloWay pump ideally suited. Send for Bulletin #14 which describes the full line of FloWay Vertical pumps.

FLOWAY Pumps

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FIESE & FIRSTENBERGER MFG., Inc.
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Contact your FloWay distributor

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Buffalo, New York
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The Kase Company
Portland, Oregon
Pacific Pumping Company
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Houston, Texas
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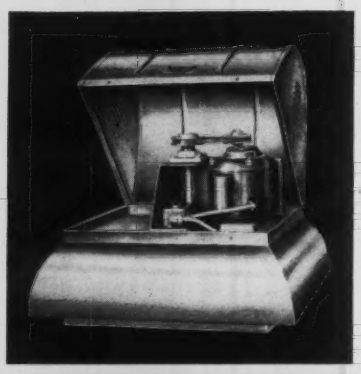
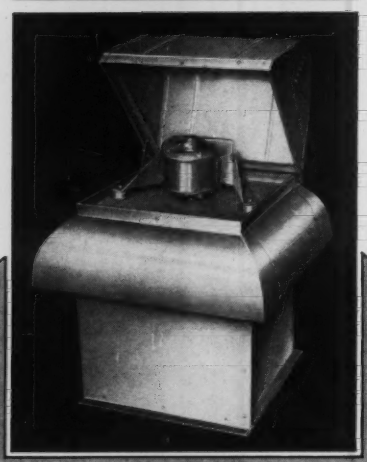
Pacific Pumping Company





Aladdin
AIR HANDLING EQUIPMENT

ROOF VENTILATORS

- THIRTEEN SIZES
- SELF CONTAINED
- QUIET OPERATING

ALADDIN Type V Roof Ventilators are available in a complete range of sizes... direct and belt driven. Units can be furnished in both curb mounted or extended base types. Ruggedly built, the type V units have been designed for those installations where positive year around powered ventilation is required, and when properly installed, will give years of efficient trouble free service.

Write for complete data

ALADDIN HEATING CORPORATION
1111 WEST AVENUE 137 • SAN LEANDRO, CALIFORNIA

WHO'S WHAT

Continued

▸ *VILTER MFG. CO.*—David N. McCormick, district manager, Pittsburgh office.

▸ *POWERS REGULATOR CO.*—Paul M. Duff, manager of new branch at 1610 W. Fourteenth St., Little Rock, Ark.

▸ *REZNOR MFG. CO.*—Walter Poinski, district sales manager for eastern Ohio.

▸ *TUBE FORGINGS OF AMERICA, INC.*—William E. Hutchins, general manager of sales, Portland, Oregon; J. J. Hansen, regional sales manager, Houston; Frank DeNina, inside sales, Houston; Earl Marrs, division sales manager, Oklahoma, Kansas, Arkansas.

▸ *WHITE-RODGERS CO.*—F. J. Maney, New York district manager; Harold E. Tettambel, Des Moines district manager.

▸ *BALTIMORE AIRCOIL CO., INC.*—Sweiger-Davidson Co., Chicago representative; A. C. Dean Co., Miami and southeast Florida representative; Richard K. Peck, Jr., representative in Tampa, Jacksonville, surrounding counties of Florida; James F. Hayes associated with James R. McQuaide, representative in eastern Pennsylvania and southern New Jersey; Thomas B. Gilliam Co., representative in northern Texas, northern Louisiana, Oklahoma.

▸ *PIONEER MFG. CO.*—John F. Blake, manager of San Diego, Calif. district office.

▸ *A. M. BYERS CO.*—Raphael J. Larko, sales engineer for Pittsburgh and Chicago sales territories.

▸ *DRAYER-HANSON DIV., NATIONAL-U.S. RADIATOR CORP.*—Mechanical Equipment & Engineering, Inc., representative in southern Idaho and eastern Oregon.

▸ *JOHN L. CLEMMY CO., INC.*—Ralph J. Pinto and John L. Dunn, operating sales activities of new branch office at 968 Farmington Ave., West Hartford, Conn.

▸ *TUBE TURNS DIV., CHEMETRON CORP.*—Holliday Steel Warehouse Div., Jones & Laughlin Corp., distributor in Indianapolis, Ind.; Master Supply Co., distributor in Aurora, Ill.

SIMPLE—4-step water treatment IMPROVES Air Conditioning

End scale, slime and corrosion troubles in air conditioning water with Oakite Airefiner No. 52. All it takes is a ten-minute daily check up by one man. This way you maintain high cooling efficiency and you reduce out-of-service time, too.

How? With a simple four step program. (1) Charge water initially with Oakite Airefiner No. 52. (2) Test water daily. (3) Add upkeep when necessary. (4) Drain system and replace with new, charged water on a periodic basis.

That's all there is to it. Airefiner No. 52 checks slime and algae growth, prevents scale build-up and minimizes corrosion. It leaves tubes clean for efficient heat exchange. It's safe. It's inexpensive.

For explanatory drawings and full details on this time and trouble saving method, ask your local Oakite Technical Service Representative, or write Oakite Products, Inc., 51A Rector Street, New York 6, N. Y.

OAKITE

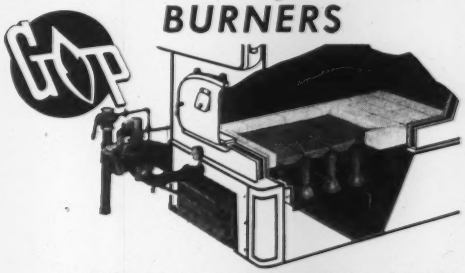
In our 51st year

specialized
WATER TREATING
materials

Technical Service Representatives in Principal Cities of U. S. and Canada

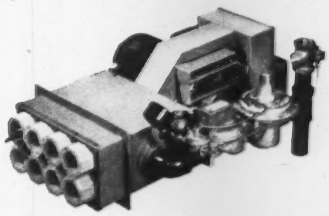
*"Planned Performance"**

BURNERS



For heating and power boilers. 23 sizes listed in Catalog No. A-10.

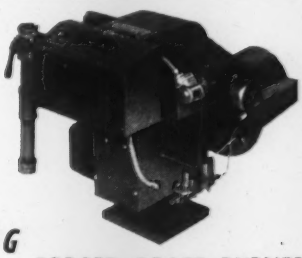
BLUE LINE UPSHOT ATMOSPHERIC GAS BURNER



Fully automatic, packaged assembly. Sizes listed to 28 million BTU/HR in Catalog C-10

TURBO-FIRE POWER TYPE GAS BURNER

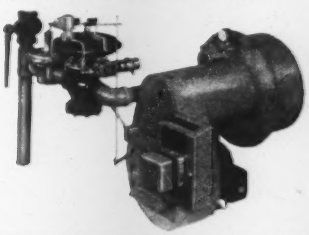
MODEL R
Capacities up to
2¼ million BTU/HR
Catalog E-61



TURBO-RING
FORCED DRAFT BURNERS

Gas, oil, or combination Gas-Oil burner. No stack required on boilers equipped for pressure firing.

MODEL FGR
Capacities 1 to 9
million BTU/HR
Catalog E-51



* PLANNED — Factory assembled, pre-wired for "Bolt-in" installation.

* PERFORMANCE — Custom matched to individual boilers for quiet, efficient operation.

Gordon & Piatt also manufacturer of a complete line of domestic conversion burners plus large dual-fuel units. Write for literature and complete information.

Gordon & Piatt
P. O. Box 914
Winfield, Kansas

MEETINGS & CONVENTIONS

MARCH 14-18—*National Association of Corrosion Engineers, annual conference and corrosion show.* Memorial Auditorium, Dallas, Tex. Information: National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Tex.

MARCH 21-24—*2nd Annual Industrial Ventilation Conference.* North Carolina State School of Engineering, Raleigh, N.C. Conducted by Dept. of Mechanical Engineering of School of Engineering and College Extension Division; sponsored by Occupational Health Section of North Carolina State Board of Health. Information: College Extension Div., P.O. Box 5125, State College, Raleigh, N.C.

MARCH 29-31—*22nd Annual American Power Conference.* Hotel Sherman, Chicago. Information: Conference Director, R. A. Budenholzer, Mechanical Engineering Dept., Illinois Institute of Technology, 3300 Federal St., Chicago 16.

APRIL 4-5—*American Society of Mechanical Engineers* and *Mechanical Engineering Dept., University of Florida, Solar Energy Symposium.* Room 512, Engineering and Industries Bldg., University of Florida, Gainesville, Fla. Information: Professor John C. Reed, Head, Mechanical Engineering Dept., University of Fla.

APRIL 4-7—1960 *Nuclear Congress and International Atomic Exposition.* New York Coliseum, New York City. Information: International Atomic Exposition, 117 S. 17th St., Philadelphia 3, Pa.

APRIL 4-7—*Oil Heat Institute of America, Convention and Exposition.* Convention: Park-Sheraton Hotel, New York; Exposition: Coliseum, New York. Information: Oil Heat Institute of America, Inc., 500 5th Ave., New York 36.

APRIL 5-7—1960 *Spring Conferences of the Building Research Institute.* Statler-Hilton Hotel, New York City. Information: Milton C. Coon, Jr., BRI executive director, 2101 Constitution Ave., N.W., Washington 25, D.C.

APRIL 25-29—*American Welding Society, annual meeting and exposition.* Los Angeles. Information: American Welding Society, 33 W. 39th St., New York 18.

APRIL 27-30—*Western Air Conditioning, Heating Ventilating and Refrigeration Exhibit and Conference.* Shrine Exposition Hall, Los Angeles. Information: Western Air Conditioning Industries Association, 3443 S. Hill St., Los Angeles 7.

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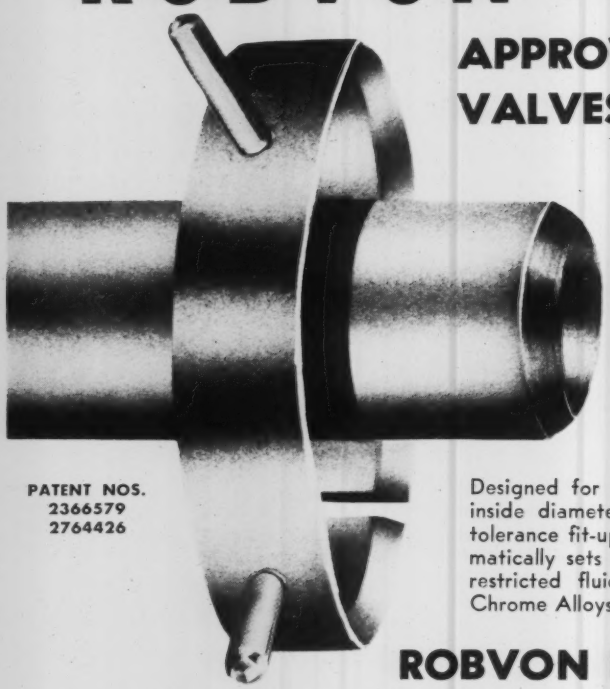

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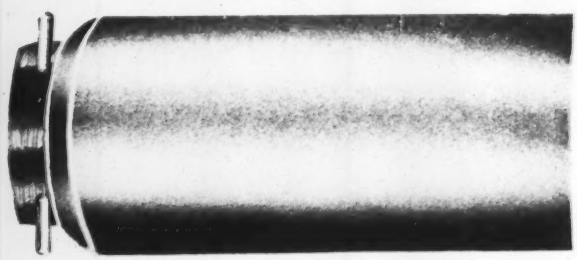

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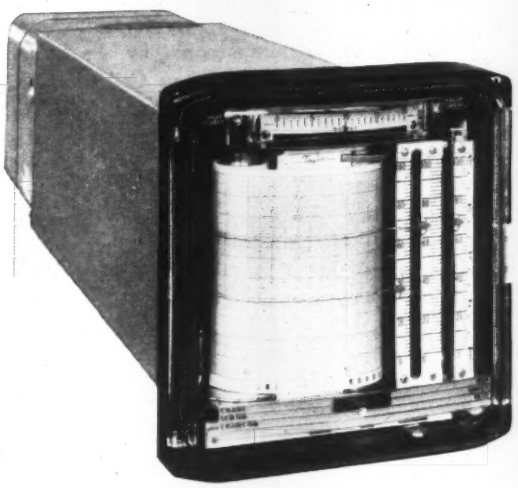

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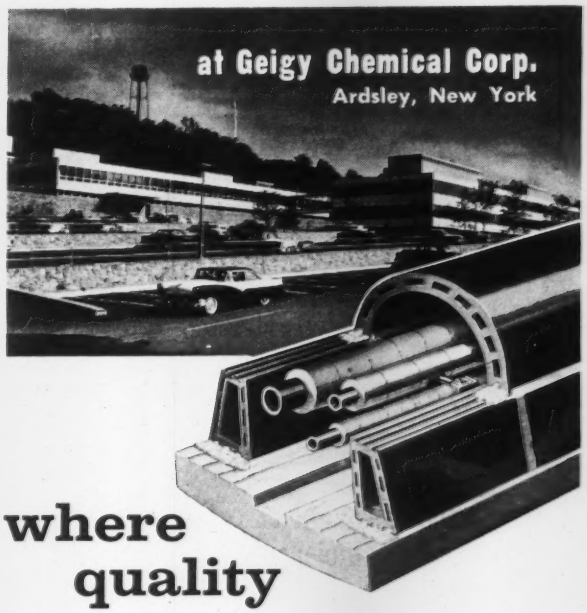

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MEETINGS & CONVENTIONS

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MAY 9-12—*Instrument Society of America. 2nd Instrument-Automation Conference and Exhibit.* Civic Auditorium and Brooks Hall, San Francisco, Calif. Information: Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

JUNE 5-9—*9th National Plastics Exposition and SPI National Conference*, sponsored by the Society of Plastics Industry, Inc. Exposition: Coliseum, New York City, Conference: Commodore Hotel, New York City. Information: The Society of Plastics Industry, Inc., 250 Park Ave., New York 17.

JUNE 6-9—*National District Heating Association 51st Annual Meeting.* Grove Park Inn, Asheville, N.C. Information: National District Heating Association, 827 N. Euclid Ave., Pittsburgh 6, Pa.

JUNE 13-15—*American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., annual meeting*, Vancouver, B.C., Canada. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 62 Worth St., New York 13, N.Y.

JULY 25-29—*13th International Congress on Occupational Health.* Waldorf-Astoria Hotel, New York. Information: Dr. Leo Wade, 15 W. 51 St., New York, N. Y.

SEPT. 7-9—*Joint Automatic Control Conference*, Massachusetts Institute of Technology, Cambridge, Mass.

OCT 17-21—*48th Annual National Safety Congress.* Industrial safety sessions, Conrad Hilton, Pick-Congress, Sheraton Towers, Morrison, and La Salle hotels, Chicago. Information: R. L. Forney, secretary, National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

NOV. 28-*DEC.* 2—*24th National Exposition of Power and Mechanical Engineering.* Under auspices of the American Society of Mechanical Engineers. New York Coliseum. Information: International Exposition Co., Inc., 480 Lexington Ave., New York 17.

OCT 12-15—*Cast Bronze Bearing Institute and Non-Ferrous Founders' Society annual meetings.* Grove Park Inn, Asheville, N.C. Information: Non-Ferrous Founders' Society, 1604 Chicago Ave., Evanston, Ill.

1961

FEB 13-16—*American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.*, semi-annual meeting and exposition, Chicago, Ill.

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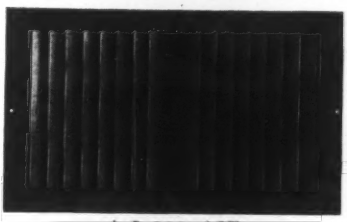
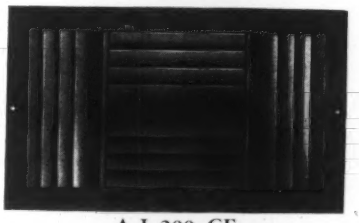


A-J 200 AIF



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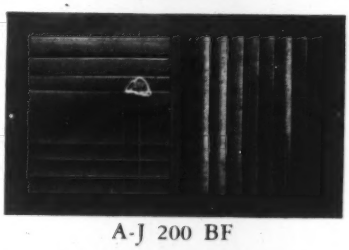

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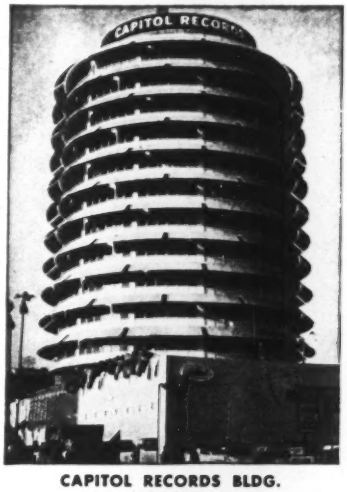

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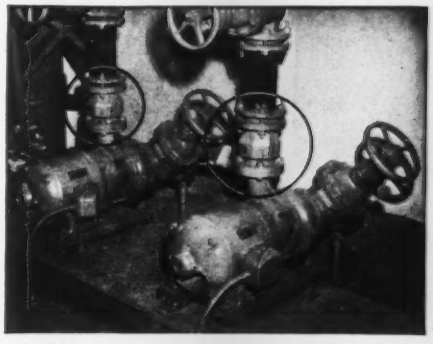

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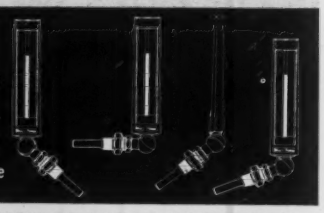

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Limits of Allowable Concentrations of Atmospheric Pollutants. Books 1, 2, *and* 3. Translations of U.S.S.R. reports. OTS, U. S. Dept. of Commerce, Washington 25, D. C.

Measurement of Secondary Stresses in Pipelines 30/*PR*. 76 pp. American Gas Association, 420 Lexington Ave., New York 17, N. Y.

Nuclear Radiation Engineering—by F. W. Hutchinson. The Ronald Press Co., 15 E. 26 St., New York 10, N. Y.

A Digest of State Air Pollution Laws, Public Health Service Publication 711. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. $.75.

Mechanical Estimator's Guide, 1960 *Edition*. 56 pp. Technical Guide Publications, 224 N. E. 59 St., Miami 37, Fla.

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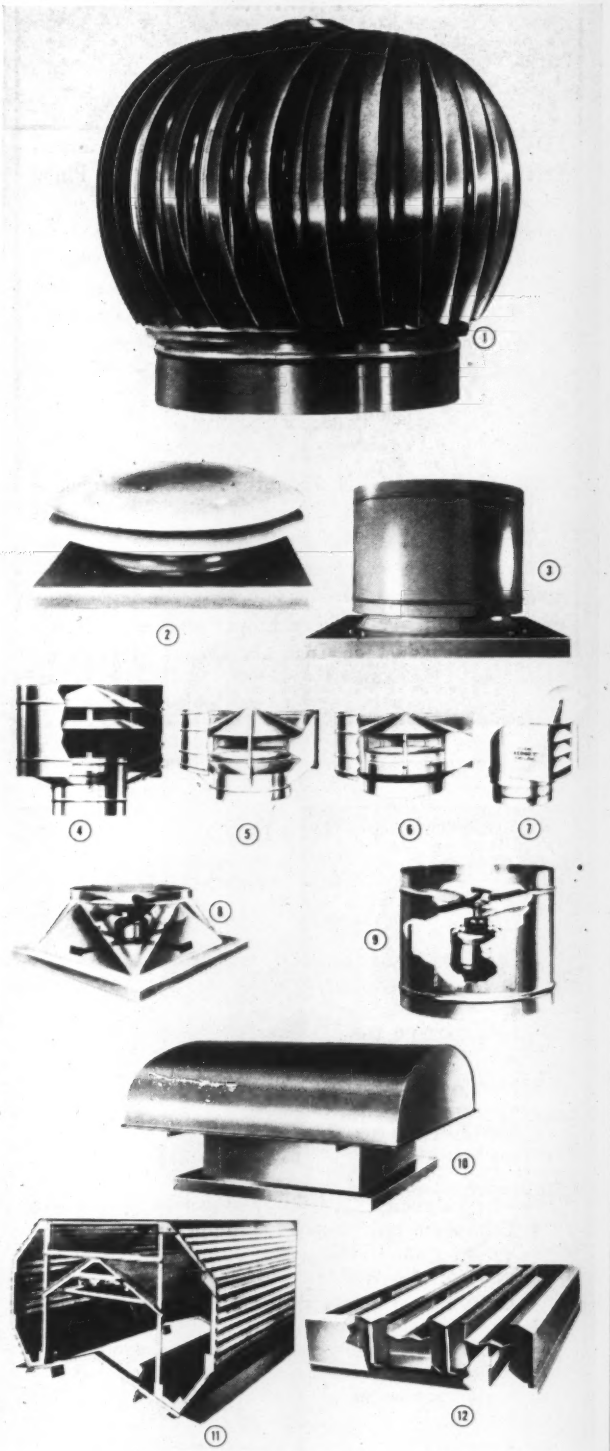

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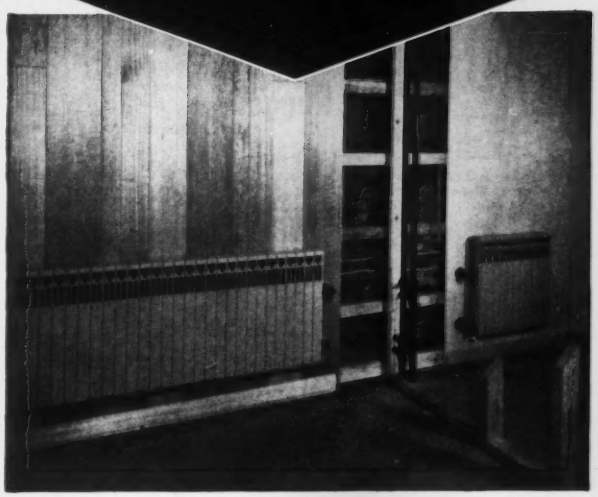

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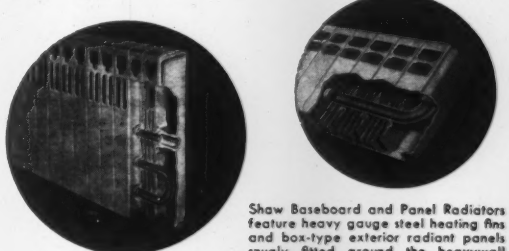

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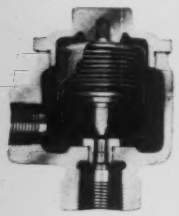

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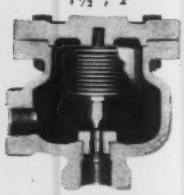
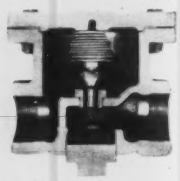


TYPE C-250 Freeze-Proof

TYPE Y-200



TYPE B-250

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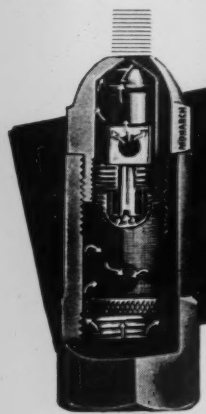

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Obituaries

Edward P. Bailey, Sr.

EDWARD P. BAILEY, Sr., 87, Counsel and former President, of the National Airoil Burner Co., Philadelphia, Pa., passed away January 4, 1960.

Mr. Bailey was co-founder of the company he headed until 1958. He was one of 10 men who in 1923, organized the American Oil Burner Association, now the Oil Heat Institute of America, and was president of that organization for a number of terms.

John C. Pangborn

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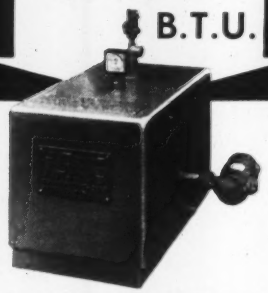

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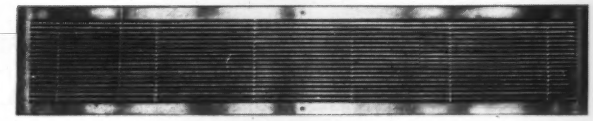

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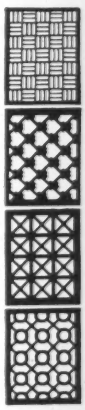

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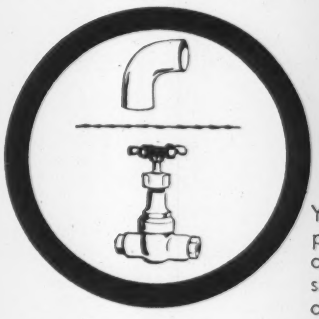

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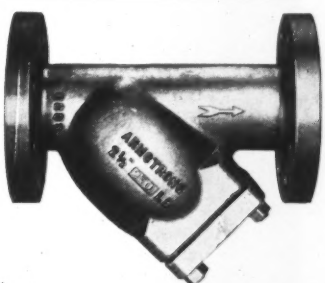

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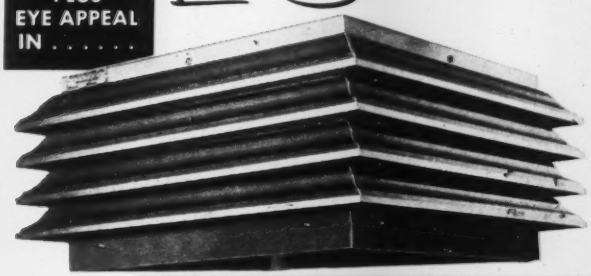

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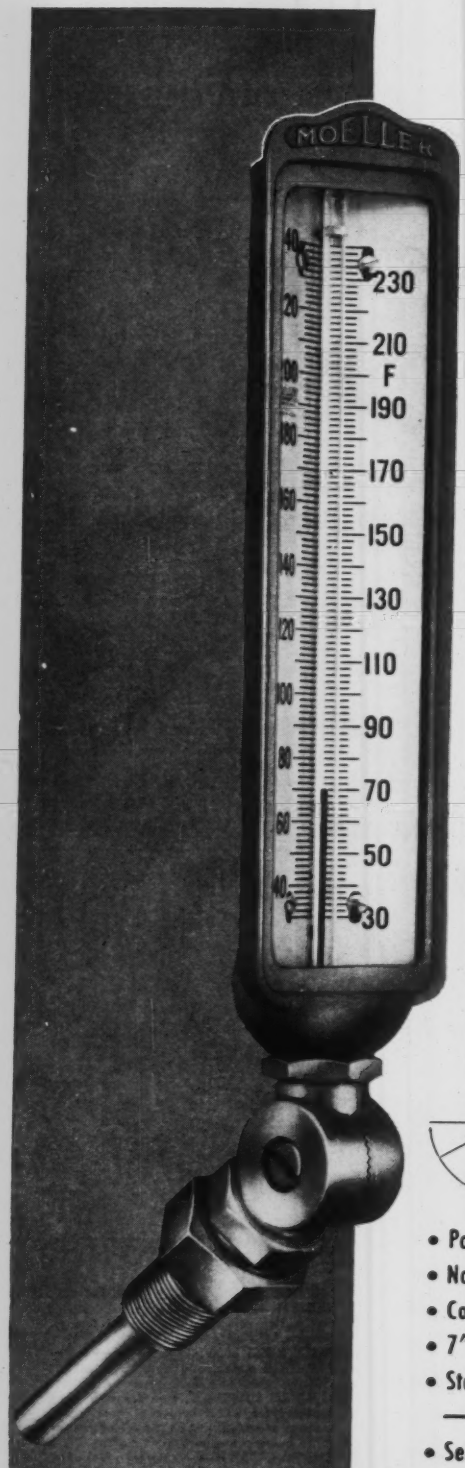

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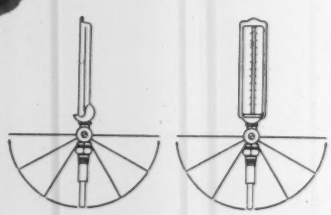

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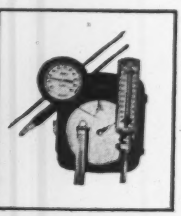

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Harold M. Shonberg

HAROLD M. SHONBERG, 49, president of Alpha Metals, Inc. and the Alpha-loy Corp. was killed December 5 at Palm Desert, California in a mid-air collision of the plane in which he was being given a demonstration flight.

Mr. Shonberg organized his firm in 1930. He had previously taken over I. Shonberg, Inc., a company founded by his grandfather in 1871 as a metal refinery, then reorganized by his father in 1912 as Standard Rolling Mills, Inc.

Warren G. Jennings

WARREN G. JENNINGS, 73, retired vice president of the Minneapolis-Honeywell Regulator Co. died December 10 after a long illness.

Mr. Jennings joined Honeywell in 1912 and was a branch manager in Milwaukee, Chicago, and Boston. He was made a vice president in 1927 and retired from the company six years ago.

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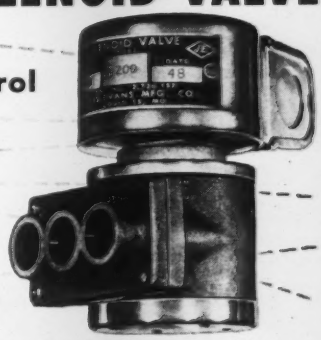

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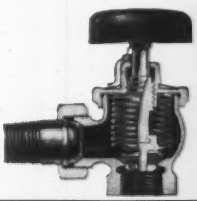

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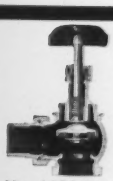
Sarco No. 1247 Spring-Packless Steam Radiator Valve Modulating Type. (Also for hot water, No. 1239)



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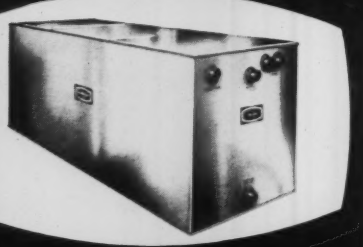

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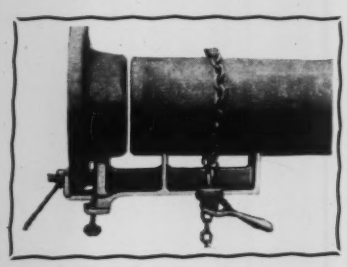

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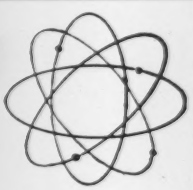

Positions available in Plant Engineering division for graduate chemical or mechanical engineers with 3 to 5 years' experience in industrial ventilating systems.

Background should include work on air purifiers, dust removal equipment. Must be capable of assuming supervisory responsibilities.

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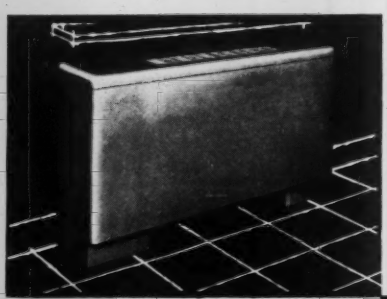
for quality, engineered heating, ventilating and air conditioning products



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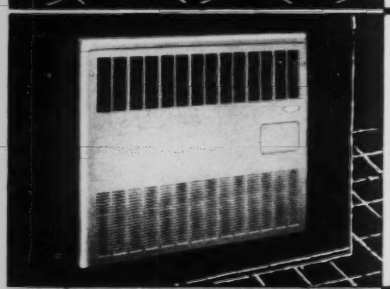

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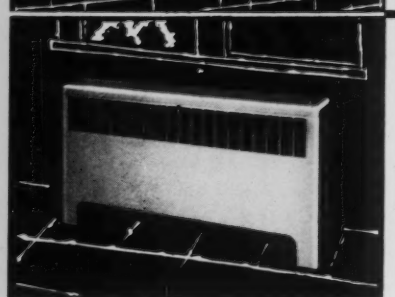

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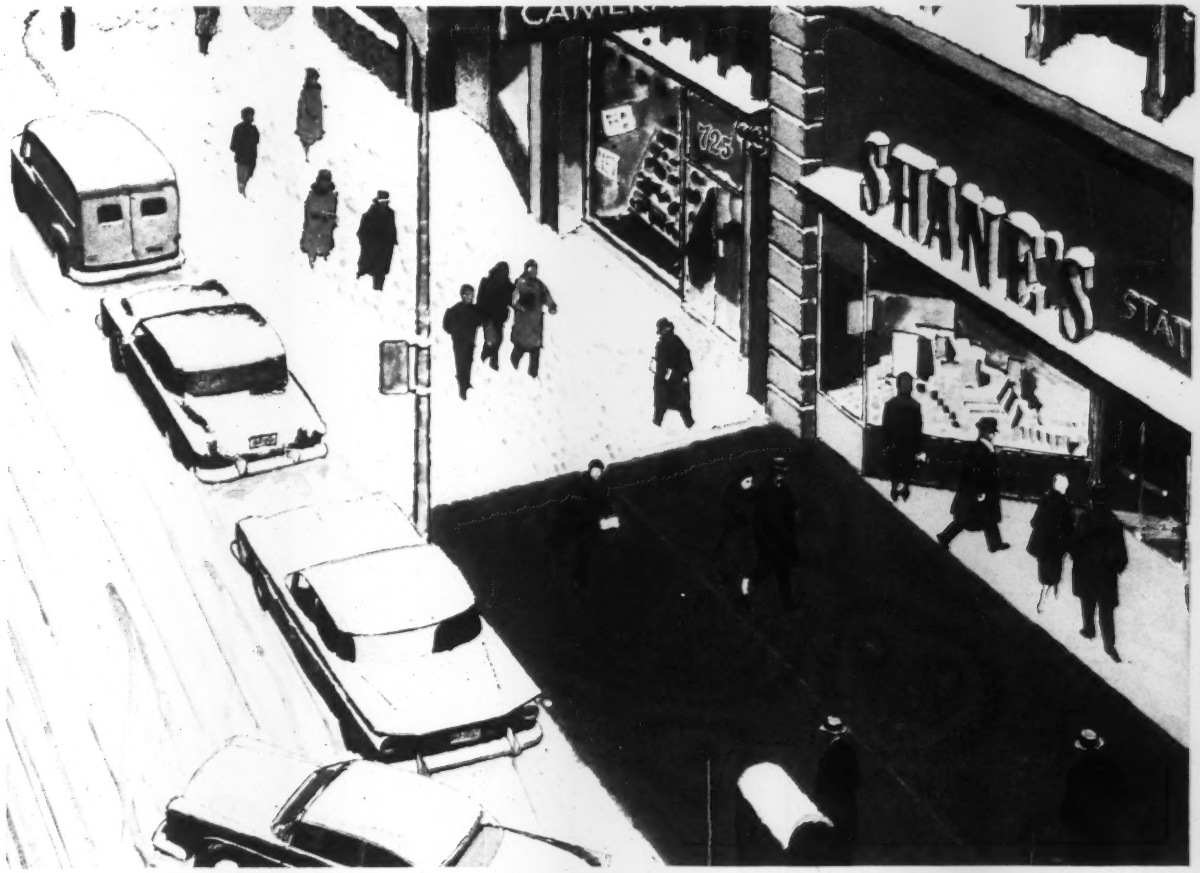

steel pipe snow melting systems pull customers in, provide walking safety, eliminate sidewalk maintenance

Today's store traffic competition is keen. That's why modern retailers are so aware of their "exterior image." The sales impressions their fronts and window displays create often mean the difference between profit and loss.

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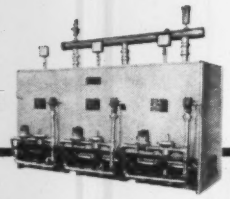

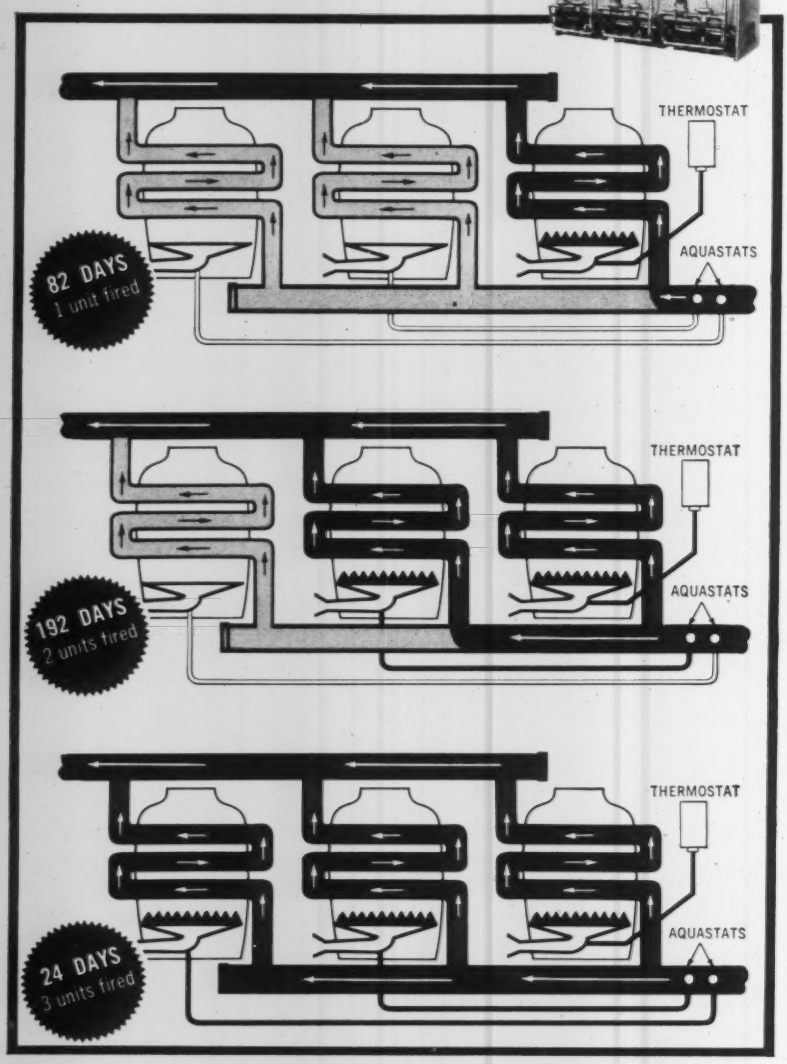

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FIRST IN HYDRONIC GAS HEAT

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Tough installation! To provide ample clearance of 20 ft. Spang Pipe was installed at ceiling level, had to be "woven" through girders. Sizes ranged from ½" to 10".

"SPANG steel pipe is as near to perfect pipe as you can get"

says Mr. Ray Hilton, President and General Manager, Higham-Hilton Plumbing Co., Salt Lake City, Utah

Easy threading! Characteristic uniformity of Spang Pipe provided fast, accurate threading on the Wagner Bag job. All connections were either welded or coupled.

Wagner Bag Company Building heating, cooling and plumbing systems serviced by 2 miles of Spang Steel Pipe

"Spang Steel Pipe is a good, uniform pipe, easy to thread and bend, and has a smooth interior finish free of any obstructions," says Mr. Hilton. "About 90% of the pipe installed on the Wagner Bag Company job is exposed; it makes a good, clean appearance.

"We used Spang Pipe on this job because of our past experience with it, and because we could get good delivery when we needed it. It gave us a smooth, trouble-free installation. We expect it to provide good service for the life of the building. I think it's one of the best products on the market."

For new construction, renovation or routine maintenance, you can't beat Spang Steel Pipe!

It's quality-controlled in manufacturing to provide uniformity throughout . . . tested and inspected to assure top-quality performance at the job site and in service . . . proven by thousands of installations. Your Spang Distributor can provide fast service on your order. Give him a call. Make it Steel Pipe . . . Make it Spang!

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General Contractor: Tolboe & Harlin, Salt Lake City
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SPANG CW STEEL PIPE

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Subsidiary of Armco Steel Corporation ARMCO

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with

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"pre-packaged"

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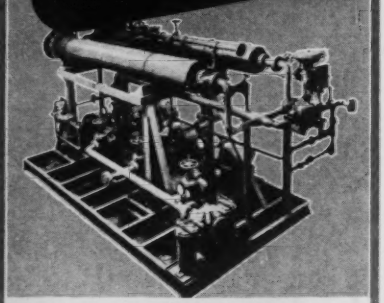

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- **"Honest", solid construction, excellent engineering assure long life, trouble-free operation.**
- **Compact units save space.**

EAGAN fuel oil pump and heater sets heat to 300° F, pump to 400 psi and have capacities to 3000 gph. Single or duplex units are available for steam or electric drive. Duplex "electro-steam" sets provide for electrical failure by incorporating one steam pump and one electric motor driven pump. Other EAGAN sets can be made to your special requirements.

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with Chain Guide

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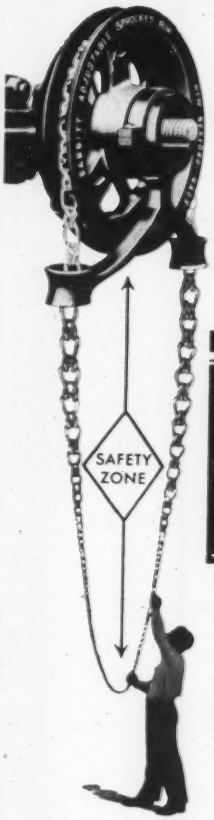

The distance between the floor of your plant and your overhead valves is a DANGER ZONE when piled up boxes or even ladders are used to reach the valves.

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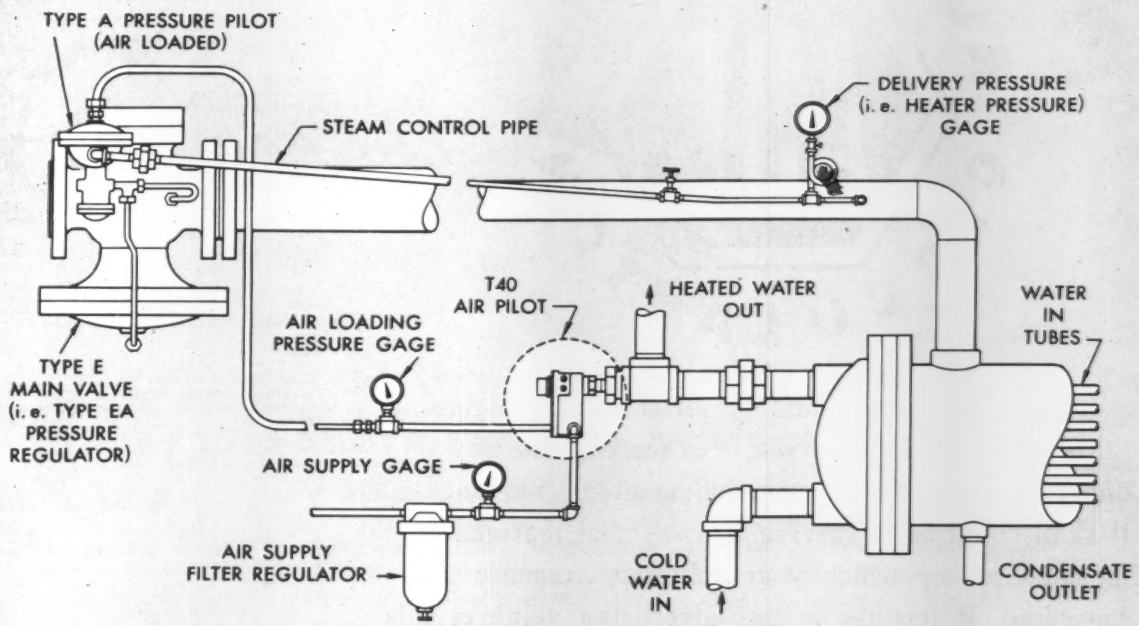
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- Field reversible for heating or cooling

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Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

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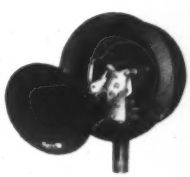

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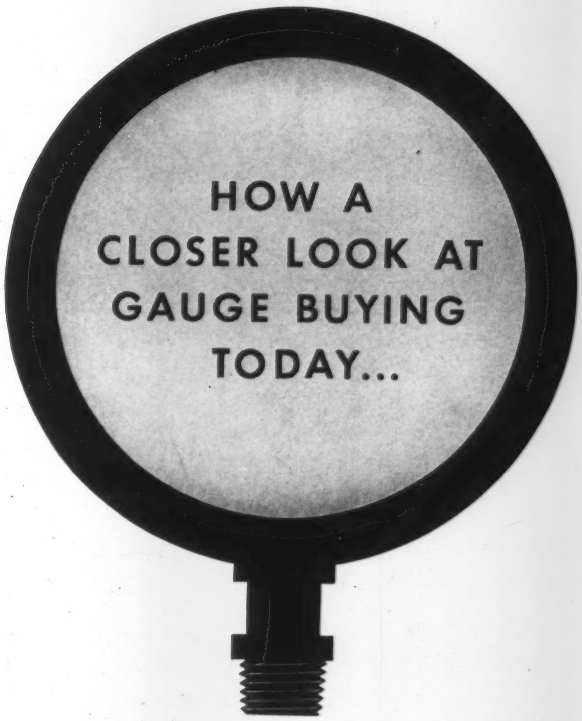

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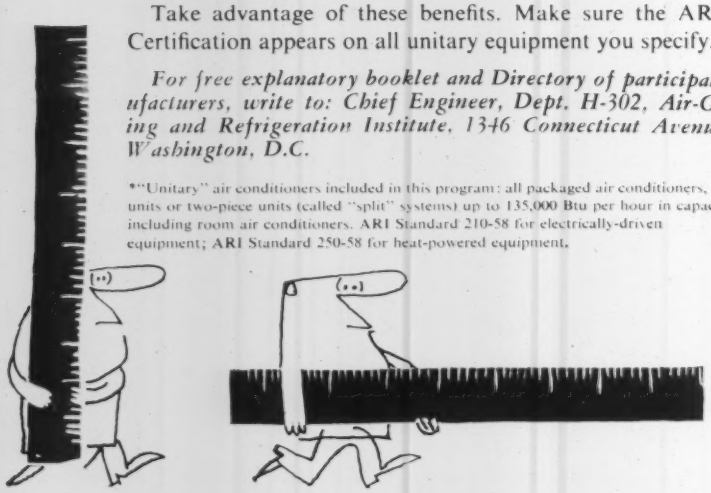

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